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// JOURNAL
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LINEAR PROGRAMMING AND FARM MANAGEMENT ANALYSIS*

JAMES N. BOLES**
University of California

ONCE upon a time there was an agricultural economist whose specialty was applied farm management research. Taking great pride in keeping up to date in his field, he had avidly read, over the years, each issue of *This Journal* and applied each new research method as it was developed.[1]

As soon as he realized that a new technique, variously called "linear programming," "activity analysis," and "mathematical programming," was applicable to farm management problems, he set about acquiring the skills necessary to use it.

The Problem

His current research activity was directed at developing optimum resource allocations for certain farms in central California faced with cotton acreage restrictions, so he decided to use the data he had collected pertaining to a typical 160-acre farm located in northern Kern County. His problem, then, was the old economic one of using the services of a set of scarce

* Giannini Foundation Paper No. 140.

** The author is grateful for the encouragement of his associates at the Giannini Foundation and for the careful review and helpful suggestions by Dr. Frederick V. Waugh and Professor Richard A. King.

Like Sune Carlson's, his contribution is not one of melody but of arrangement, orchestration, and variation. Those who wish to "hear" the original composition should consult Robert Dorfman, *Application of Linear Programming to the Theory of the Firm*, University of California Press, Berkeley and Los Angeles, 1951; A. Charnes, W. W. Cooper, and A. Henderson, *An Introduction to Linear Programming*, John Wiley and Sons, Inc., New York, 1953; and Richard A. King, "Some Applications of Activity Analysis in Agricultural Economics," *This Journal*, XXXV: 5, Dec., 1953. An earlier paper employing a somewhat different analytical procedure is Frederick V. Waugh, "The Minimum-Cost Dairy Feed," *This Journal*, XXXIII: 3, Aug., 1951.

[1] Such articles as Murray R. Benedict, "The Opportunity Cost Basis of the Substitution Method in Farm Management," *This Journal*, XIV: 3 and 4, July and October, 1932, and S. V. Ciriacy-Wantrup, "Economics of Joint Costs in Agriculture," *This Journal*, XXIII: 4, Nov. 1941, were important milestones in his development, the second introducing him to vector notation.

resources in such a way as to maximize net revenue. The resources of the typical farm, some fixed only in the short run, included a certain number of acres of land, the labor and management potential of the farm operator, a collection of agricultural implements, a certain fund of money or working capital, and an irrigation system which could supply no more than a limited amount of water. During the year, the farm operator could use his working capital to hire the services of or buy other resources such as labor, fertilizer, gasoline, insecticides, and seed. His problem, then, was to choose simultaneously the particular crop or crops to be grown the following planning period, the number of acres of land he would allocate to each of these crops, and the particular method to use in the production of each of these crops so that the net cash return[2] would be as large as possible.

Assumptions

He could continue to assume, just as he had when using marginal analysis, that: (1) to the extent that additional resources could be purchased or hired at all, the farm operator could purchase or hire them at a constant going rate; (2) he would be forced to use uncertain forecasts of prices of inputs and outputs and yields per acre of the various crops he might produce; (3) he would act as though these uncertain forecasts were subjectively certain to him; (4) if certain crop rotations produced yields different from the individual crops grown separately, he would be forced to use a planning period sufficiently long to include the rotation cycle; and (5) once the planning period was chosen, the outcome of each planning period would be independent of that of any other planning period.[3]

The Data

He soon found that the information needed for linear programming was almost exactly the same that he had used in budget studies. In fact, the linear programming procedure itself seemed to be very similar to that of budgeting. The essence of both techniques for short-run problems was to develop an allocation of the limited resources owned by the farm operator, to compare that allocation successively with alternative allocations, and to select the one which maximized net cash return.

The typical farm operator in the area selected, being familiar with the production of cotton, potatoes, alfalfa, barley, and sugar beets, wanted an allocation of cropland for some combination of these crops. For use in budget analyses, the economist had already set up for each of these crops a calendar of operations listing the time of application and the quantity of

[2] By net cash return, I mean the difference between total revenue and total variable costs.

[3] Not all of these assumptions are necessary either for marginal analysis or linear programming. They are assumptions commonly made and serve to place the two techniques on comparable ground.

the various inputs per acre and the average yield corresponding to that particular method of production.[4] Unfortunately, he possessed information relating only to one method for each crop. Had the information been available, he would have prepared calendars of operation and average yields for other methods corresponding to different timing and/or quantities of such inputs as water, fertilizer, etc. Had there been any known interactions between crops in successive years, he would have prepared calendars of operation, rotation schedules, and average yields for each of several such combinations.

Relevant information from the calendars of operation was summarized in Table 1. The essential data needed for each method of production were: (1) the quantities per acre required of the fixed resources controlled by the

TABLE 1. RESOURCES AND PROCESSES AVAILABLE TO THE FARM OPERATOR

Item	Unit	Quantity of owned resources	Resource requirements				
			Process 1	Process 2	Process 3	Process 4	Process 5
			Cotton	Potatoes	Alfalfa	Sugar beets	Barley
Resources:							
Cropland	Acres	150	1.0	1.0	1.0	1.0	1.0
Water, period 1	Acre-inches	2,200	4.0	13.3	15.8	13.0	6.3
Water, period 2	Acre-inches	2,110	16.6	0	22.2	42.7	0
Water, period 3	Acre-inches	730	7.8	0	11.1	3.3	0
Cotton acreage allotment	Acres	60	1	0	0	0	0
Potato limitation	Acres	50	0	1	0	0	0
Net cash return	Dollars		207	200	86	136	29

farm operator which might restrict his choice and (2) an estimate of the net cash return per acre (expected yield times expected price minus expected variable costs). Assuming initially that the typical farm operator had available sufficient working capital, family or permanent hired labor, and equipment to undertake any possible allocation of the 5 crops to the 150 acres of cropland, the economist decided that the only fixed factors which might restrict the operator's choice of a production plan were: (1) the number of acres available, (2) the amount of water available during different periods of the season, and (3) the size of the acreage allotment for cotton. In addition to these absolute limitations, he assumed that the typical farm operator would voluntarily restrict his potato acreage to less than 50 acres due to the

[4] Calendars of operations for these crops may be found in Chester O. McCorkle, Jr., and Trimble R. Hedges, *Northern Kern County Cotton-Potato Farms*, Mimeographed Report No. 137, California Agricultural Experiment Station, October, 1952.

extreme variability of potato prices. He noted that if only one resource, say land, were limited, no complicated apparatus would be required to choose the optimum plan. The method which yielded highest net cash return per acre would be chosen and all the acres would be cultivated growing that particular crop and using that particular method.

The first column of Table 1 listed the quantities of resources which might limit the choice of a production plan. Thus, no more than 150 acres could be planted; no more than 2,200 acre-inches of water could be used during period 1; no more than 2,110 acre-inches of water could be used during period 2; no more than 730 acre-inches of water could be used during period 3; no more than 60 acres of cotton could be planted; and no more than 50 acres of potatoes would be planted. Each of the remaining columns (excluding the entry corresponding to net cash return) defined the unit level of a process for producing the corresponding crop. Thus, 3 units of the first process, a process for producing cotton, would require 3 acres of land, 12 acre-inches of water in period 1, 49.8 acre-inches of water in period 2, 23.4 acre-inches of water in period 3, and 3 acres of cotton allotment, just 3 times the quantities required for the unit level and yielding 3 times as much net cash return. He assumed *constant returns* and *divisibility* of the fixed inputs. In other words, he assumed that 0.35 acre, 7.63 acres, or any amount up to the total acreage could be planted to a particular crop using the *same technique of production*, the *same relative proportions of all inputs*, and getting the *same relative output*. That is, he assumed that expansion of any one crop would be limited only by the quantities of the fixed resources available. He also assumed that, as he had defined the various processes, the results obtained from any two processes operated simultaneously would be just the sum of the results of the same two processes operated separately.

His problem of simultaneously choosing the particular crop or crops, the method of production, and the number of acres of each crop selected could then be translated into the equivalent problem of selecting the number of units of the available processes to include in his production plan. His goal was the same in either formulation, maximization of net cash return; his limitations remained the same, the production plan could not require (since his initial interest was in the short-run solution) use of more of the owned resources than were available.

Mathematical Tools

Objective

Now that he had summarized the required information and assured himself that the processes he had defined possessed the necessary properties of divisibility, linearity, and independence, he decided that the next step would be to investigate the mathematical tools needed for further analysis. He found that his calculus would not be needed but that he would have to

acquaint himself with a few of the basic ideas of vector algebra. After studying several books,[5] he made the following summary of the concepts and operations with which he should be familiar.

1. A vector is an ordered set of numbers, for example,

$$\begin{pmatrix} 3 \\ 5 \\ 2 \end{pmatrix}.$$

In general, a vector, P, composed of three numbers or elements may be represented by

$$P = \begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix},$$

where the subscript indicates the position of the element. If there are several different vectors, each may be identified with a subscript, for example, the *ith* vector composed of n elements can be represented by

$$P_i = \begin{pmatrix} a_{1i} \\ a_{2i} \\ \cdot \\ \cdot \\ \cdot \\ a_{ni} \end{pmatrix},$$

where the first subscript of an element denotes the position and the second, the vector to which the element belongs. Each column of the table above, listing for one unit of a particular process the quantities of the scarce factors used, can be considered a vector, for example,

$$P\ \text{cotton} = \begin{pmatrix} 1 \\ 4.0 \\ 16.6 \\ 7.8 \\ 1 \\ 0 \end{pmatrix}.$$

2. Addition or subtraction of vectors are defined as the addition or subtraction of the corresponding elements. Thus,

$$\begin{pmatrix} 2 \\ 4 \end{pmatrix} + \begin{pmatrix} 3 \\ 9 \end{pmatrix} = \begin{pmatrix} 5 \\ 13 \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} 3 \\ 9 \end{pmatrix} - \begin{pmatrix} 2 \\ 5 \end{pmatrix} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}.$$

[5] Thomas L. Wade, *The Algebra of Vectors and Matrices*, Addison-Wesley Press, Inc., Cambridge, Mass., 1951, is an introductory text particularly appropriate for self-study.

Consequently, vectors must have the same number of elements (be of the same order) to make possible addition to or subtraction from one another.

3. Corresponding to the zero of the set of real numbers, the zero or null vector is defined as a vector which has all of its elements equal to zero. Thus,

$$\begin{pmatrix}1\\3\\2\end{pmatrix} = \begin{pmatrix}1\\3\\2\end{pmatrix} + \begin{pmatrix}0\\0\\0\end{pmatrix} \quad \text{or} \quad \begin{pmatrix}1\\3\\2\end{pmatrix} - \begin{pmatrix}1\\3\\2\end{pmatrix} = \begin{pmatrix}0\\0\\0\end{pmatrix}.$$

4. For two vectors to be equal to one another, they must be of the same order and corresponding elements must be equal.

5. The multiplication of a vector by a number (scalar) is defined as the multiplication of each element of the vector by that number, thus,

$$(3)\begin{pmatrix}4\\6\\2\end{pmatrix} = \begin{pmatrix}12\\18\\6\end{pmatrix}.$$

6. A linear combination of two vectors is defined as the sum or difference of two vectors each multiplied by a number, for example,

$$3\begin{pmatrix}4\\6\\2\end{pmatrix} + 2\begin{pmatrix}3\\2\\6\end{pmatrix} = \begin{pmatrix}12\\18\\6\end{pmatrix} + \begin{pmatrix}6\\4\\12\end{pmatrix} = \begin{pmatrix}18\\22\\18\end{pmatrix}.$$

The result is itself a vector of the same order as the first two. This vector equation can also be written as

$$3P_1 + 2P_2 = P_0, \text{ where } P_1 = \begin{pmatrix}4\\6\\2\end{pmatrix}, \ P_2 = \begin{pmatrix}3\\2\\6\end{pmatrix}, \text{ and } P_0 = \begin{pmatrix}18\\22\\18\end{pmatrix}.$$

This single vector equation, then, contains the same information as the following arithmetic equations:

$$3\cdot 4 + 2\cdot 3 = 18$$
$$3\cdot 6 + 2\cdot 2 = 22$$
$$3\cdot 2 + 2\cdot 6 = 18.$$

7. The set of all vectors of the same order formed by allowing each element of the vector

$$P = \begin{pmatrix}a_1\\a_2\\\cdot\\\cdot\\\cdot\\a_n\end{pmatrix}$$

to take on the value of any of the real numbers is a set analogous to the set of real numbers with respect to the operations so far defined. To illustrate, the sum of any two real numbers is itself a real number. The product of any two real numbers is itself a real number. The sum of any two vectors of the same order is itself a vector of the same order. The product of any vector by a real number is itself a vector of the same order. Any linear combination of vectors is itself a vector of the same order. This general set of vectors, all possessing n elements, is defined as a vector space of dimension n. To illustrate, the vector space of dimension 2 is defined as the entire set of vectors with two elements formed by allowing each element independently to assume any real number from -00 to $+00$.

8. Under certain conditions, a linear combination of n non-zero vectors, $P_1, P_2, \cdots, P_n$ can be chosen which will be equal to any vector belonging to the n-dimensional vector space. To illustrate this point for a vector space of dimension 2, consider the two vectors,

$$P_1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \quad \text{and} \quad P_2 = \begin{pmatrix} 0 \\ 1 \end{pmatrix}.$$

A linear combination of these two vectors can be found which will be equal to any other two-dimensional vector selected, say

$$P_0 = \begin{pmatrix} a_{10} \\ a_{20} \end{pmatrix}.$$

The problem is to find k_1 and k_2 such that $k_1P_1+k_2P_2=P_0$. This vector equation is equivalent to the two algebraic equations:

$$k_1 \cdot 1 + k_2 \cdot 0 = a_{10}$$
$$k_1 \cdot 0 + k_2 \cdot 1 = a_{20}.$$

These two equations are independent equations in two unknowns and thus can be solved:

$$k_1 = a_{10} \quad \text{and} \quad k_2 = a_{20}.$$

Consider the two vectors,

$$P_3 = \begin{pmatrix} 1 \\ 2 \end{pmatrix} \quad \text{and} \quad P_4 = \begin{pmatrix} 2 \\ 4 \end{pmatrix},$$

and try to find k_3 and k_4 such that $k_3P_3+k_4P_4=P_0$. This is equivalent to the two algebraic equations:

$$k_3 \cdot 1 + k_4 \cdot 2 = a_{10}$$
$$k_3 \cdot 2 + k_4 \cdot 4 = a_{20}.$$

It is obvious that $P_4=2P_3$ and that, consequently, the second algebraic

equation is twice the first. Thus, these two equations are not independent and have no unique solution. They can only be true if $2a_{10} = a_{20}$. Therefore, a linear combination of these two vectors cannot be found which will equal every two-dimensional vector which might be selected.

A set of non-zero vectors for which a linear combination can be found which is equal to any selected vector in the vector space is called a "basis" of the vector space. Every basis of a vector space of dimension n contains n vectors.

A test as to whether or not a set of n vectors forms a basis for the vector space of dimension n is to determine if it is possible to form a linear combination of the vectors so that (1) the linear combination equals the null vector and (2) the coefficients are not all zero. If it is *not possible* to meet these specifications, the set of vectors *forms* a basis; if it is *possible* to meet these specifications, the set of vectors *does not form* a basis.

For example, is it possible to find k_1 and k_2 where either k_1 or k_2 or both k_1 and k_2 are not zero such that

$$k_1P_1 + k_2P_2 = k_1\begin{pmatrix}1\\0\end{pmatrix} + k_2\begin{pmatrix}0\\1\end{pmatrix} = \begin{pmatrix}0\\0\end{pmatrix}?\ (P_1 \text{ and } P_2 \text{ are defined above.})$$

This is equivalent to the pair of equations:

$$k_1 \cdot 1 + k_2 \cdot 0 = 0$$
$$k_1 \cdot 0 + k_2 \cdot 1 = 0.$$

To satisfy these equations, both k_1 and k_2 must equal zero. Thus, the specifications are not met. Consequently, these two vectors form a basis of the vector space of dimension 2, and linear combinations of them can be used to represent any other two-dimensional vector.

Applying the same technique to the vectors, P_3 and P_4 where

$$P_3 = \begin{pmatrix}1\\2\end{pmatrix} \quad \text{and} \quad P_4 = \begin{pmatrix}2\\4\end{pmatrix},$$

the following algebraic equations result:

$$k_3 \cdot 1 + k_4 \cdot 2 = 0$$
$$k_3 \cdot 2 + k_4 \cdot 4 = 0.$$

Here, $k_3 = -2$ and $k_4 = 1$ is one pair of values for k_3 and k_4, neither of which is zero, which satisfies the equations and the specifications. Thus, P_3 and P_4 do not form a basis for the vector space of dimension 2.

Just to emphasize that P_1 and P_2 do not form the only basis of the vector space of dimension 2, consider P_1 and P_5, where

$$P_5 = \begin{pmatrix}1\\3\end{pmatrix}.$$

Is it possible to find k_1 and k_5 such that at least one of these coefficients shall not be zero and such that

$$k_1P_1 + k_5P_5 = \begin{pmatrix} 0 \\ 0 \end{pmatrix}?$$

The resulting algebraic equations are:

$$k_1 \cdot 1 + k_5 \cdot 1 = 0$$
$$k_1 \cdot 0 + k_5 \cdot 3 = 0.$$

From the second equation, k_5 equals zero and, if this is substituted into the first equation, then k_1 equals zero, so P_1 and P_5 also form a basis of the vector space of dimension 2.

This same technique can be extended to vector spaces of any dimension, say n, in order to determine whether or not a particular collection of n vectors forms a basis for the corresponding vector space.[6]

9. In order to clarify some of these concepts, it is convenient to relate vectors of the second order to points plotted on coordinate paper, that is, to points on a plane; vectors of the third order to points in a three-dimensional space, etc.

Let the first element of a two-dimensional vector be identified with the distance along the x_1 or horizontal axis and the second element be identified with the distance along the x_2 or vertical axis of a cartesian coordinate system. Then, the vector,

$$P_1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix},$$

corresponds to the point (1, 0), or the point one unit to the right of the origin on the x_1-axis. The vector,

$$P_2 = \begin{pmatrix} 0 \\ 1 \end{pmatrix},$$

corresponds to the point (0, 1), or the point one unit above the origin on the x_2-axis.

The vector resulting from the addition of P_1 and P_2,

$$\begin{pmatrix} 1 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \end{pmatrix},$$

corresponds to the point (1, 1), one unit above and one unit to the right of the origin, the point at the fourth corner of the parallelogram formed by the origin and the points corresponding to P_1 and P_2.

[6] The essential point is that, if the value of the determinant formed by the n vectors is zero, then the vectors are not independent and cannot form a basis of the n-dimensional vector space.

The vector resulting from the addition of P_1 and P_5,

$$\begin{pmatrix}1\\0\end{pmatrix}+\begin{pmatrix}1\\3\end{pmatrix}=\begin{pmatrix}2\\3\end{pmatrix},$$

corresponds to the point (2, 3), also the point at the fourth corner of the parallelogram formed by the origin and the points corresponding to P_1 and P_5.

Now, consider the vector,

$$P_5=\begin{pmatrix}1\\3\end{pmatrix},$$

and the set of vectors formed by the product k_5P_5 where k_5 is successively 0, 1, 2, 10, etc. The corresponding points are (0, 0), (1, 3), (2, 6), (10, 30), etc. Thus, the locus of all points for k_5 ranging from 0 to $+00$ is the straight line starting at the origin and having at each point the x_1 value just 1/3 of the x_2 value, both x_1 and x_2 positive.

Recall that for the two non-zero vectors of the second order, P_3 and P_4, to be dependent and consequently *not* to form a basis of the two-dimension vector space, it was necessary that it be possible to select k_3 and k_4 in such a way that

$$k_3P_3+k_4P_4=\begin{pmatrix}0\\0\end{pmatrix},$$

where either k_3 was not zero or k_4 was not zero or both were not zero. Recall that

$$P_3=\begin{pmatrix}1\\2\end{pmatrix}\quad\text{and}\quad P_4=\begin{pmatrix}2\\4\end{pmatrix}.$$

Consequently, $P_4=2P_3$ and $k_3P_3+k_4P_4=(k_3+2k_4)P_3$. Thus, the reason that P_3 and P_4 could not form a basis was that all the points corresponding to linear combinations of them fell on the line through the origin and thus could not describe any point not on that line.

Three vectors of the third order are dependent and thus do not form a basis only if linear combinations of them correspond to points on a line through the origin or to points on a plane through the origin, thus preventing them from describing any selected point in three-space which does not lie on that particular line or plane.

Linear Programming Example

After completing this summary of vector concepts, the economist decided to set up a hypothetical case much simpler than his real one in order to get some practice in the use of these new mathematical tools.

The Data

He assumed that a farm operator owns three limited factors: land, his own potential labor, and working capital. He defined a vector

$$P_0 = \begin{pmatrix} a_{10} \\ a_{20} \\ a_{30} \end{pmatrix}$$

where a_{10} is the number of acres of land, a_{20} is the number of man-months, and a_{30} is the amount of working capital which is available.

He then assumed that this farm operator is restricted to only four productive processes, either different crops or different methods of producing the same crop and defined four vectors, P_1, P_2, P_3, and P_4. In each of these vectors, the first element is equal to one acre, the second element is equal to the number of man-months per acre required for the particular process, and the third element is equal to the cash outlay per acre prior to harvest.

Disposal Processes

He realized that (in the short run, at least) situations might develop where this hypothetical farmer would be better off financially if some of his resources were left idle. He might be land-poor and have insufficient labor or capital to work more than a fraction of his acres. He might possess more working capital than he can profitably use on his limited acres. So three new processes were defined, P_5, P_6, and P_7, where

$$P_5 = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \quad P_6 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, \quad \text{and} \quad P_7 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}.$$

These processes he called *disposal* processes since they perform no function other than to allow some of the owned resources to be idle. Since the first element of P_5 is 1 and the other elements are zero, one unit of P_5 allows one acre to remain idle. One unit of P_6 allows one man-month of labor potential to remain unused, while one unit of P_7 allows one dollar of working capital to remain in the bank. Obviously, these processes return no direct revenue to the farm operator but do afford him a greater freedom of choice.

He then assumed numerical values for the elements of the first four processes and for the vector listing the quantity of limited resources and prepared the following table:

TABLE 2

Resources	Processes							
	P_0	P_5	P_6	P_7	P_1	P_2	P_3	P_4
Land	4	1	0	0	1	1	1	1
Labor	6	0	1	0	4	2	2	1
Capital	8	0	0	1	1	3	4	2

He then associated with the corresponding productive processes 1 through 4 the net cash return per acre (predicted yield per acre times predicted price minus predicted variable costs) of \$3.00, \$2.00, \$4.00, and \$1.00.

Now he was ready to proceed with the maximization problem. He wanted to allocate the limited resources to the various processes in such a way that all of the resources would be used up (keeping in mind that some of them may be "used" in disposal processes) and so that the total net cash return would be as large as possible. "Allocation of resources" was equivalent to choosing a linear combination of processes or vectors 1 through 7. To meet the specification that all the limited resources be used up, this linear combination had to equal P_0. Since the processes could only be operated in one direction (one could not have an input of corn to obtain land, labor, and capital), the coefficients of the linear combination had to be positive. In general, several such linear combinations were possible, so the problem involved choosing the one which yielded maximum revenue.

Procedure

The procedure he followed was to select three processes to form a *basis* of the three-dimensional vector space. Any one of several sets of three vectors would have performed this service, but it was convenient to select the three disposal vectors as a starting point. Every one of the vectors could then be represented as a linear combintion of P_5, P_6, and P_7. For example, $P_0=4P_5+6P_6+8P_7$, or

$$\begin{pmatrix}4\\6\\8\end{pmatrix} = 4\begin{pmatrix}1\\0\\0\end{pmatrix} + 6\begin{pmatrix}0\\1\\0\end{pmatrix} + 8\begin{pmatrix}0\\0\\1\end{pmatrix}.$$

From the nature of the three disposal vectors, the coefficients of the linear combination on the right of the equation are equal to the values of the elements of the vector on the left side of the equation. Consequently, any three-dimensional vector,

$$\begin{pmatrix}a_1\\a_2\\a_3\end{pmatrix},$$

could be expressed as a linear combination of P_5, P_6, and P_7 by using a_1 as the coefficient of P_5, a_2 as the coefficient of P_6, and a_3 as the coefficient of P_7. Thus, Table 3 was prepared which summarized all of the vector equations formed in this manner:

TABLE 3

P_j	P_0	P_5	P_6	P_7	P_1	P_2	P_3	P_4
P_5	4	1	0	0	1	1	1	1
P_6	6	0	1	0	4	2	2	1
P_7	8	0	0	1	1	3	4	2

Thus, the column under P_1 was just a shorthand way of writing

$$P_1 = 1P_5 + 4P_6 + 1P_7.$$

First Production Plan

The column under P_0 corresponded to the initial allocation of resources which would then be compared to alternative allocations. The vector equation, $P_0=4P_5+6P_6+8P_7$, meant simply that all of the available resources as listed in P_0 would be exhausted if 4 units of land, 6 units of labor, and 8 units of working capital were allowed to remain idle.

Improving the Production Plan

While the three disposal vectors operated at the lvels of 4, 6, and 8, respectively, gave him a convenient starting point, it was obvious that disposing of all of the scarce resources would hardly maximize revenue, so he decided to introduce the process which would yield the *largest net cash return per acre*, P_3. This was equivalent to selecting a new basis containing P_3 and only two of the processes in the old basis and was also equivalent to working out another allocation of the cropland which would result in a higher net cash return.

In order to activate P_3, it was necessary to take resources from the three processes then constituting the basis, P_5, P_6, and P_7. His next problem was to determine how many units of this process could be used before one of the scarce resources would be fully utilized. This could be determined by dividing each element under P_0 by the corresponding element under P_3. The ratio of 8/4 or 2 was the smallest of the three so only 2 units or 2 acres could be allocated to process 3 before all of the working capital would be used up. Two acres of process 3 required 4 units of labor so there remained idle 2 acres of land and 2 units of labor. Consequently,

$$P_0 = 2P_5 + 2P_6 + 2P_3 + 0P_7, \text{ or}$$

$$\begin{pmatrix} 4 \\ 6 \\ 8 \end{pmatrix} = 2\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} + 2\begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} + 2\begin{pmatrix} 1 \\ 2 \\ 4 \end{pmatrix} + 0\begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}.$$

In other words, only two units of process 3 could have been used before all resources were taken from the original allocation to process 7. Net cash return equaled \$8.00 since the net revenue per acre for process 3 was \$4.00.

Algebraic Derivation

More formally, the derivation of the new allocation was as follows: He wanted to obtain an equation which would show P_0 as a linear combination of P_3 and only two of the vectors, P_5, P_6, and P_7. He wanted the coefficients of this linear combination to be positive. He knew the following two equations:

$$P_0 = 4P_5 + 6P_6 + 8P_7 \quad \text{and}$$
$$P_3 = 1P_5 + 2P_6 + 4P_7.$$

These two equations were combined as follows:

$$P_0 = 4P_5 + 6P_6 + 8P_7 + k(P_3 - 1P_5 - 2P_6 - 4P_7)$$

where k would be chosen in such a way that k is positive, one of the coefficients of P_5, P_6, or P_7 would equal zero, and the other two coefficients would be positive. The coefficient k is free to vary since the term in parentheses is equal to zero.

$$\begin{aligned} P_0 &= (4 - 1k)P_5 + (6 - 2k)P_6 + (8 - 4k)P_7 + kP_3 \\ &= 1(4/1 - k)P_5 + 2(6/2 - k)P_6 + 4(8/4 - k)P_7 + kP_3. \end{aligned}$$

Thus, it was apparent that k had to be chosen to equal the smallest of the ratios appearing in the parentheses so that the coefficient corresponding to the term in which that smallest ratio appeared would equal zero and the remaining coefficients would be positive. Hence, k was set equal to 8/4 or 2, so the equation became

$$P_0 = 2P_5 + 2P_6 + 0P_7 + 2P_3.$$

Second Production Plan

This equation alone was sufficient to give him an allocation of his resources which was better than the first one. The first plan was to allow all of his resources to remain idle, resulting in a zero net cash return. The new plan was to use two units of process 3 and thus to obtain a net cash return of \$4.00 per unit or \$8.00 and allow 2 acres of land and 2 man-months of labor to remain idle. However, as in budget analyses, he still had to compare this plan with alternatives which might prove to be still more profitable. The procedure he followed to make this comparison was to determine by how much the processes then utilized would have to be reduced in order to obtain enough of the scarce resources to operate successively one unit of each of the processes not then appearing in the production plan. He then could compare the corresponding net cash return of the unit newly intro-

duced with the sacrifice of income corresponding to the reduction of the old processes and determine if one unit of any of the processes not then used would be more profitable. In order to make these comparisons, it was necessary for him to prepare a new table of vector equations expressing each of the vectors P_1 through P_7 as linear combinations of the vectors in the new basis, P_5, P_6, and P_3.

(a) $P_5 = 1P_5 + 0P_6 + 0P_3$

(b) $P_6 = 0P_5 + 1P_6 + 0P_3$

(c) Here it was not so easy. He wanted to obtain a vector equation of the form,

$$P_7 = k_5P_5 + k_6P_6 + k_3P_3, \quad \text{or}$$

$$\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = k_5 \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} + k_6 \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} + k_3 \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix}.$$

The algebraic equivalent of this vector equation enabled him to solve for the three unknown coefficients.

$$0 = k_5 + 0 + k_3$$
$$0 = 0 + k_6 + 2k_3$$
$$1 = 0 + 0 + 4k_3.$$

From the last equation, $k_3 = 1/4$; from the second equation, $k_6 = -1/2$; and from the first equation, $k_5 = -1/4$. Thus,

$$P_7 = -1/4P_5 - 1/2P_6 + 1/4P_3.$$

(d) From here on, the problem was less difficult since the remaining vectors were already expressed as linear combinations of P_5, P_6, and P_7, as listed in Table 1, while P_5, P_6, and P_7 had already been expressed as linear combinations of P_5, P_6, and P_3.

$$\begin{aligned} P_1 &= 1P_5 + 4P_6 + 1P_7 \\ &= 1P_5 + 4P_6 + 1(-1/4P_5 - 1/2P_6 + 1/4P_3) \\ &= 3/4P_5 + 3\ 1/2P_6 + 1/4P_3 \end{aligned}$$

(e)
$$\begin{aligned} P_2 &= 1P_5 + 2P_6 + 3P_7 \\ &= 1P_5 + 2P_6 + 3(-1/4P_5 - 1/2P_6 + 1/4P_3) \\ &= 1/4P_5 + 1/2P_6 + 3/4P_3 \end{aligned}$$

(f)
$$P_3 = 0P_5 + 0P_6 + 1P_3$$

(g)
$$\begin{aligned} P_4 &= 1P_5 + 1P_6 + 2P_7 \\ &= 1P_5 + 1P_6 + 2(-1/4P_5 - 1/2P_6 + 1/4P_3) \\ &= 1/2P_5 + 0P_6 + 1/2P_3. \end{aligned}$$

With these calculations out of the way, he was prepared to fill out a new table of vector equations. In order to make the revenue comparisons, he added a new column and three new rows. He defined c_j as the net revenue per acre for the jth process, z_j as the net revenue resulting from the linear combination of the three vectors in the basis which used the same quantity of resources as one unit of the jth process. For example, the equation, $P_0=2P_5+2P_6+2P_3$, indicated that 2 units of process 5, 2 units of process 6, and 2 units of process 3 used exactly the resources available as listed in P_0. P_5 and P_6 yielded no revenue, while each unit of P_3 yielded \$4.00 of net revenue. Thus, total net revenue equaled $z_0=2\cdot 0+2\cdot 0+2\cdot 4=\$8.00$.

For still another illustration, the equation, $P_1=3/4P_5+7/2P_6+1/4P_3$, indicated that the resources used in one unit of process 1 was exactly the same as the resources used in 3/4 units of P_5, 7/2 units of P_6, and 1/4 units of P_3. The net revenue corresponding to this linear combination of the three vectors in the basis was equal to $z_1=3/4\cdot 0+7/2\cdot 0+1/4\cdot 4=\$1.00$.

The resulting table was:

TABLE 4

c_j			0	0	0	3	2	4	1
	P_j	P_0	P_5	P_6	P_7	P_1	P_2	P_3	P_4
0	P_5	2	1	0	$-1/4$	3/4	1/4	0	1/2
0	P_6	2	0	1	$-1/2$	7/2	1/2	0	~~1~~ 0
4	P_3	2	0	0	1/4	1/4	3/4	1	1/2
z_j		8	0	0	1	1	3	4	2
z_j-c_j			0	0	1	-2	1	0	1

Just as in the first table, each column represented a vector equation expressing each of the processes as a linear combination of the three vectors in the basis.

Since the elements of the vectors in the basis were quantities of the three limited resources, each of the equations in the table represented the particular combination of the three vectors in the basis which utilized exactly the same quantities of resources as one unit of the corresponding vector. For example, the last column represented the equation: $P_4=1/2P_5+0P_6+1/2P_3$. This meant that one unit or one acre of process 4 used exactly the same resources as the combination of 1/2 unit of process 5 and 1/2 unit of process 3. But one unit of process 4 would yield only \$1.00 of net revenue, while the combination would yield zero revenue for 1/2 unit of process 5 plus 1/2 (\$4.00) = \$2.00 for process 3 or a total net revenue of \$2.00. Thus, it would not pay to draw resources from the present basis, P_5, P_6, and P_3 in order to activate P_4 since for each unit increase in P_4 total net revenue would be

increased by \$1.00 and decreased by \$2.00, a net loss per unit of P_4 of \$1.00. Thus, the entries in the bottom row, $z_j - c_j$ show how much the total revenue would be *decreased* if enough resources were taken from the processes in the basis to operate the jth process at unit level.

Summary of Procedure

In order to have the principles clearly in mind, the economist reviewed the steps he had taken.

(1) He had chosen the three disposal processes as a *basis* and then expressed each of the processes as linear combinations of these three. This was equivalent to selecting a production plan as the starting point of a budget analysis.

(2) He had realized that the allocation of the limited resources to the three disposal processes would provide no net revenue, so he decided to bring into the basis or production plan the process with the largest net revenue per unit, process 3. The new allocation of resources was then given by the column under P_0 of Table 4, 2 units of P_5, 2 units of P_6, and 2 units of P_3, with the resulting net revenue given by $z_0 = \$8.00$.

(3) In order to compare this allocation of the limited resources with other potential allocations, he completed the remainder of the table so that, in turn, each vector not currently being used could be equated to a combination of the three vectors in the basis. These alternatives could then be compared revenue-wise since they employed the same amounts of the limited resources.

(4) Only processes whose $z_j - c_j$ value were negative would then be preferable to the corresponding combination of the three vectors in the basis. In this case, only the value for $z_1 - c_1$ was negative, so this process needed to be brought into the basis in exactly the same fashion that P_3 was originally brought into the basis.

The Third and Optimum Production Plan

In order to bring P_1 into the basis, it was necessary to express P_0 as a linear combination of P_1 and only 2 of the 3 processes then in the basis, P_5, P_6, and P_3 in such a way that all of the coefficients would be positive.

This he did by combining the following two equations from Table 4:

$$P_0 = 2P_5 + 2P_6 + 2P_3$$

$$P_1 = 3/4P_5 + 7/2P_6 + 1/4P_3$$

$$P_0 = 2P_5 + 2P_6 + 2P_3 + k(P_1 - 3/4P_5 - 7/2P_6 - 1/4P_3).$$

Then k was chosen as large as possible without forcing any of the coefficients to become negative.

$$P_0 = 3/4(2/3/4 - k)P_5 + 7/2(2/7/2 - k)P_6 + 1/4(2/1/4 - k)P_3 + kP_1$$

Thus, k was set equal to the smallest of the three ratios appearing in the parentheses, $k=2/7/2=4/7$, so the equation became

$$P_0 = (2 - 3/4 \cdot 4/7)P_5 + (2 - 7/2 \cdot 4/7)P_6 + (2 - 1/4 \cdot 4/7)P_3 + 4/7P_1, \quad \text{or}$$

$$P_0 = 11/7P_5 + 0P_6 + 13/7P_3 + 4/7P_1.$$

So P_6 in the earlier basis was replaced by P_1 and the remainder of the new table computed using the same procedure. The values he obtained were:

TABLE 5

c_j			0	0	0	3	2	4	1
	P_j	P_0	P_5	P_6	P_7	P_1	P_2	P_3	P_4
0	P_5	11/7	1	−3/14	−1/7	0	1/7	0	1/2
3	P_1	4/7	0	2/7	−1/7	1	1/7	0	0
4	P_3	13/7	0	−1/14	4/14	0	5/7	1	1/2
z_j		$9.14	0	4/7	5/7	3	23/7	4	2
$z_j - c_j$			0	4/7	5/7	0	9/7	0	1

He realized that this was the final table since none of the elements in the $z_j - c_j$ row were negative; that, if any of the processes not in the basis were to be expanded by drawing resources from the processes in the basis, the total net revenue would be decreased. The elements of the P_0 column indicated that the optimum allocation for this hypothetical farmer was to use 11/7 units of P_5; that is, allow 11/7 acres to remain idle and to put in 4/7 acres to crop or process 1 and 13/7 acres to crop or process 3, resulting in a net revenue of $9.14.

Marginal Value Productivities of Owned Resources

The $z_j - c_j$ values for the disposal processes not used in the final plan were especially significant. The vector equation,

$$P_6 = -3/14P_5 + 2/7P_1 - 1/14P_3,$$

meant that, if one man-month of labor were withdrawn from the resources used in the final production plan, 3/14 more units of land would become idle, P_1 would be decreased 2/7 units at a sacrifice of $2/7 \cdot \$3.00 = \$6/7$, and P_3 would be increased 1/14 units at a gain of $1/14 \cdot \$4.00 = \$2/7$. This would have resulted in a net loss of $\$6/7 - \$2/7 = \$4/7$. Conversely, if an additional man-month of labor were available to add to his stock of limited resources,

the net cash revenue would have been increased by \$4/7, the value of $z_6 - P_6$.

This gain could then be compared with the cost of acquisition of one more unit and an evaluation made as to the importance of removing that bottleneck or limitation. Thus, although he had set up the analysis to answer a short-run problem of allocation, he also obtained information helpful in answering longer-run problems.

A similar interpretation was made of $z_7 - c_7 = \$5/7$. This measured the marginal value productivity of one unit of capital. Since some land was allowed to remain idle in the final production plan, its marginal value productivity was zero.

These "shadow prices" of the three limited resources were then multiplied by their respective quantities to yield:

$$\$0 \cdot 4 + \$4/7 \cdot 6 + \$5/7 \cdot 8 = \$9.14.$$

Thus, the total net cash return was exactly allocated to the limited factors.

Real Problem

After practicing with this simple example, our economist then tackled the data presented in Table 1 and found that the optimum plan corresponding to the assumed data was to have 5 acres of barley, 16 acres of sugar beets, 19 acres of alfalfa, 60 acres of cotton, and 50 acres of potatoes with a corresponding net cash return of \$26,397.00. He then decided to illustrate graphically the results of the analysis (Figure 1).

Starting with all resources allocated to disposal processes, the situation corresponding to *a* on the horizontal scale resulted. Successively, then, cotton, potatoes, sugar beets, barley and, finally, alfalfa were introduced with the corresponding changes in allocation represented by *b*, *c*, *d*, *e*, and *f*. Net cash returns corresponding to those allocations were then plotted on the same figure.

The final table was as follows:

TABLE 6

c_j			0	0	0	0	0	0	207	200	86	136	29
	P_j	P_0	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_1	P_2	P_3	P_4	P_5
29	P_5	4.911777	1	0	−.019465	−.051159	− .277832	−1	0	0	0	0	1
0	P_7	755.423666	−6.3	1	−.107360	−.641138	9.083036	−7	0	0	0	0	0
136	P_4	16.343497	0	0	.027700	−.055402	− .027701	0	0	0	0	1	0
86	P_3	18.744726	0	0	−.008235	.106561	− .694467	0	0	0	1	0	0
207	P_1	60	0	0	0	0	1	0	1	0	0	0	0
200	P_2	50	0	0	0	0	0	1	0	1	0	0	0
z_j		26,397.20	29	0	2.49	.15	135.45	171	207	200	86	136	29
$z_j - c_j$			29	0	2.49	.15	135.45	171	0	0	0	0	0

The entries under P_0 indicated that only one resource was in excess supply, water during period 1, since the disposal process for this resource was operated at a level of 755 units or acre-inches.

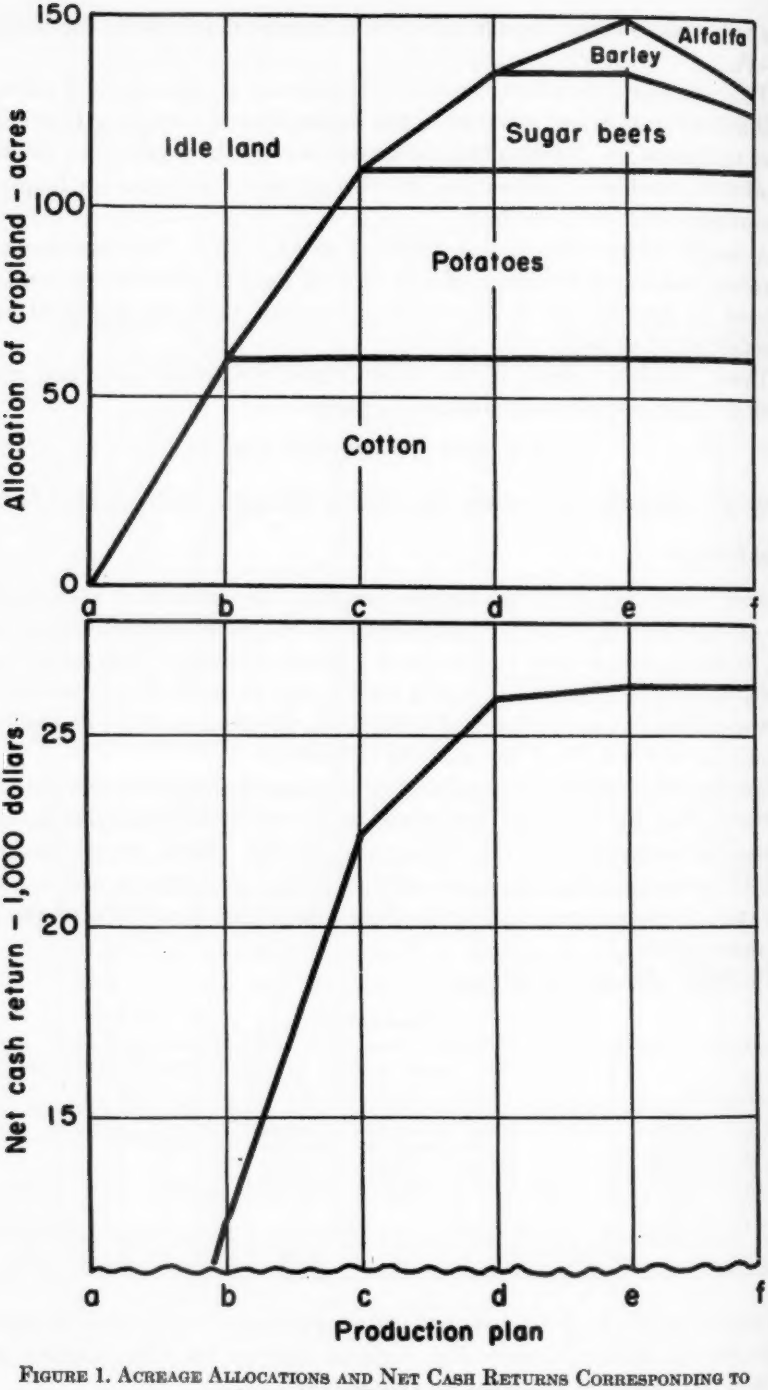

FIGURE 1. ACREAGE ALLOCATIONS AND NET CASH RETURNS CORRESPONDING TO ALTERNATIVE PRODUCTION PLANS

The Marginal Value Productivities

He found it informative to interpret the values of the $z_j - c_j$ row.

1. The marginal value productivity of land, $z_6 - c_6$, was \$29, reflecting the marginal use of land to produce barley, assisted by 6.3 acre-inches of the idle water from period 1.

2. The marginal value productivity of water during period 1, $z_7 - c_7$, was zero since it was in excess supply.

3. The marginal value productivity of water during period 2, $z_8 - c_8$, was \$2.49 per acre-inch, reflecting for an additional acre-inch of water during this period a reduction in barley, P_5, of .019 acre; a reduction in alfalfa, P_3, of .008 acre; and the use of .107 acre-inch of water from period 1 in order to increase sugar beets, P_4, by .028 acre.

4. The marginal value productivity of water during period 3, $z_9 - c_9$, was \$0.15 per acre-inch, resulting from a decrease of P_5, P_7, and P_4 and an increase in alfalfa, P_3, by .107 acre.

5. The marginal value productivity of 1 acre of cotton allocation, $z_{10} - c_{10}$, was \$135.45, the difference between the income from an acre of cotton and the income from .278 acre of barley, .028 acre of sugar beets, and .694 acre of alfalfa which would have to be sacrificed to obtain the resources used to grow an additional acre of cotton.

6. Correspondingly, the marginal sacrifice in income corresponding to a voluntary restriction of potato acreage was \$171 per acre.

Epilogue

By now, our tale of the farm management economist interested in recent additions to methodology has reached a successful conclusion. It only remains to point out that the case he solved could be made more realistic by increasing the number of processes and the number of fixed or limited resources at the expense of increasing the labor involved in filling out successive tables. The number of processes could be increased by increasing both the number of crops and the number of methods for each crop. The number of limited resources could be increased by classifying them into more homogeneous categories both with respect to quality and time of availability.

Different price structures can be assumed and their effect on optimum allocation determined. In fact, the whole range of economic problems defined under the heading of comparative statistics can be analyzed.

The principal advantages over the traditional budgetary method seem to be at least two: (1) as soon as the basic assumptions as to resources owned and processes available are set down, the remainder of the numerical analysis can be performed by a statistical clerk (see appendix); and (2) the final allocation is necessarily the optimum position relative to the maximization of net cash return, while budgetary techniques may stop before that optimum is reached.

APPENDIX

Corresponding to the simple numerical problem solved in the preceding article, consider the table where P_0 lists the amounts of the limited resources

c_j			c_5	c_6	c_7	c_1	c_2	c_3	c_4
	P_j	P_0	P_5	P_6	P_7	P_1	P_2	P_3	P_4
c_5	P_5	a_{50}	a_{55}	a_{56}	a_{57}	a_{51}	a_{52}	a_{53}	a_{54}
c_6	P_6	a_{60}	a_{65}	a_{66}	a_{67}	a_{61}	a_{62}	a_{63}	a_{64}
c_7	P_7	a_{70}	a_{75}	a_{76}	a_{77}	a_{71}	a_{72}	a_{73}	a_{74}
z_j		z_0	z_5	z_6	z_7	z_1	z_2	z_3	z_4
$z_j - c_j$			$z_5 - c_5$	$z_6 - c_6$	$z_7 - c_7$	$z_1 - c_1$	$z_2 - c_2$	$z_3 - c_3$	$z_4 - c_4$

at the disposal of the farm operator, P_1 through P_4 list the amounts of the limited resources used per acre for these different crops or methods, and

$$P_5 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, \quad P_6 = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}, \quad \text{and} \quad P_7 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}.$$

The c_j is the expected net cash return resulting from the operation of the jth process at unit level. Consequently, c_5 through c_7 equal zero.

$$z_0 = a_{50}c_5 + a_{60}c_6 + a_{70}c_7$$

$$z_1 = a_{51}c_5 + a_{61}c_6 + a_{71}c_7$$

$$z_j = a_{5j}c_5 + a_{6j}c_6 + a_{7j}c_7.$$

Since all of the c's in the left-hand column are initially zero, all of the z's will also be initially zero and the row corresponding to $z_j - c_j$ will for the first table consist of $-c_j$'s.

Procedure

1. Select the column in which the negative number having the largest absolute value appears in the $z_j - c_j$ row. In the numerical example this was the column corresponding to P_3, the crop with the largest net revenue per acre. Knowing that $z_3 - c_3$ is negative and assuming that of all the negative $(z_j - c_j)$'s it has the largest absolute value, this column should be heavily outlined to indicate that this process is to be brought into the basis.

2. To determine which of the three processes currently in the basis will be dropped from the basis, compute the ratios a_{50}/a_{53}, a_{60}/a_{63}, and a_{70}/a_{73}. Heavily outline the row corresponding to the smallest ratio. Disregard any ratio whose denominator is zero or negative. Assuming, as in the numerical

example, that the row corresponding to P_7 yields the smallest ratio, this row should be outlined as the process which is to be dropped from the basis.

3. Prepare a new table with the same headings for the columns, but with, in this case, P_3 substituted for P_7 in the column headed by P_j. Letting b's represent the elements of this new table, it will appear as follows:

c_j			c_5	c_6	c_7	c_1	c_2	c_3	c_4
	P_j	P_0	P_5	P_6	P_7	P_1	P_2	P_3	P_4
c_5	P_5	b_{50}	b_{55}	b_{56}	b_{57}	b_{51}	b_{52}	b_{53}	b_{54}
c_6	P_6	b_{60}	b_{65}	b_{66}	b_{67}	b_{61}	b_{62}	b_{63}	b_{64}
c_3	P_3	b_{30}	b_{35}	b_{36}	b_{37}	b_{31}	b_{32}	b_{33}	b_{34}
z_j		z_0	z_5	z_6	z_7	z_1	z_2	z_3	z_4
z_j-c_j			z_5-c_5	z_6-c_6	z_7-c_7	z_1-c_1	z_2-c_2	z_3-c_3	z_4-c_4

4. The elements of the row corresponding to the process just introduced into the basis, P_3, are found by dividing each of the elements in the corresponding row of the first table by the element found at the intersection of the outlined row and outlined column. Thus,

$$b_{30} = a_{70}/a_{73},\ b_{35} = a_{75}/a_{73},\ \cdots,\ b_{3j} = a_{7j}/a_{73}.$$

5. Consider any element in the second table not appearing in the row corresponding to P_3, say b_{ij}. Identify the element a_{ij} in the corresponding position in the first table and the other three corners of the rectangle formed by a_{ij}, a_{i3}, the element in the same row appearing in the outlined column, a_{7j}, the element in the same column appearing in the outlined row, and a_{73}, the element appearing at the intersection of the outlined row and column.

Then,

$$b_{ij} = a_{ij} - (a_{7j}/a_{73})a_{i3}, \quad \text{or}$$

$$b_{ij} = a_{ij} - b_{3j}a_{i3}.$$

Thus,

$$b_{50} = a_{50} - (a_{70}/a_{73})a_{53} = a_{50} - b_{30}a_{53}$$

$$b_{60} = a_{60} - (a_{70}/a_{73})a_{63} = a_{60} - b_{30}a_{63}$$

$$b_{55} = a_{55} - (a_{75}/a_{73})a_{53} = a_{55} - b_{35}a_{53}$$

$$b_{65} = a_{65} - (a_{75}/a_{73})a_{63} = a_{65} - b_{35}a_{63}$$

etc.

6. Compute the z_j's and the (z_j-c_j)'s. If all the elements of the z_j-c_j row are zero or positive, the optimum program has already been determined.

The program is given by the entries under P_0; that is, the elements in this column are the coefficients of the vector equation,

$$P_0 = b_{50}P_5 + b_{60}P_6 + b_{30}P_3.$$

The resulting net cash return is given by $z_0 = b_{50}c_5 + b_{60}c_6 + b_{30}c_3$. If some of the entries in the row corresponding to $z_j - c_j$ are negative, the whole procedure is repeated and a third table filled in whose typical element would be c_{ij}. The column with the negative $(z_j - c_j)$ having the largest absolute value would be outlined, the ratios of the elements of the column headed by P_0 to the corresponding elements of the outlined column would be computed and the row corresponding to the smallest ratio would be outlined. Ratios whose denominators are zero or negative would be disregarded. The computation of the values in this third table follows exactly the procedure used to calculate the values in the second table. The procedure is repeated until all the entries in the row corresponding to $(z_j - c_j)$ are either zero or positive.

PROBLEMS OF ORDER OF ECONOMIC AND AGRICULTURAL POLICY

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THE discussions on problems of agricultural policy in Parliament, in newspapers and in agricultural periodicals indicate that large differences of opinion continue not only in questions of detail, which is natural, but as regards the broad objectives of agricultural policy as well. A scientific approach may help to clarify principles by trying to determine "the social-geometrical position" (an expression used by the Swiss economist Fritz Marbach) which agricultural policy is holding or should be holding today within the total system of economy and economic policy. In speaking of problems of order (Ordnungsprobleme) in agricultural policy we mean (1) to adapt agricultural policy to the political and social concepts of free democracy; (2) to adapt it to the inherent laws of the economic process in such a way that the functioning of those laws will be controlled and supported, but not hindered; (3) to co-ordinate it appropriately with general economic policy; and (4) to harmonize its specific aims and measures with the circumstances of time and place.

These four problems themselves are subject to an order of precedence. Political and social principles are supreme values which are recognized as axiomatic. As we know from the experience of our own lives, it is not sufficient for the conduct of one's life to have principles. One must also know how to apply them. This brings us to the other pole of our existence, the material foundations, which have largely the objective character of fate. We certainly do not go as far as orthodox Marxism which regards political and social convictions only as an ideological superstructure of the conditions of production; on the other hand, we do acknowledge that the economic process follows its inherent laws in the continuous repetition of its course and has its own dynamics in its development in time. When a century and a half ago the natural laws of the economic process were discovered, many, inspired by the first enthusiasm and full of abhorrence of the mercantile system of privileges and police intervention, thought that a satisfactory order of the economy was secured by the economic laws alone. Economic history has shown that this optimism was not justified. The opinion, however, widely held today by marginal producers and their political and administrative representatives, that the economic laws exist solely in the imagination of the theoreticians and that

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an economic system can only be created through economic policy, is equally wrong.

This opens a wide field for scientific inquiry. Research has to clarify how far the economic laws alone are able to create an order which corresponds to the predominant value-judgments and what corrections and supplements have to be induced by a legal order. Thus we are faced with the problem that *neither the natural order of the economy nor the legal order of the State alone guarantees a rational order of the economy.* "The laws of the natural order are not sufficient in themselves because human action is not sufficiently fixed and limited by the prices, which serve as planning data; the laws of the legal order are equally insufficient because the infinite variety of human behavior cannot be completely enough circumscribed by them. It is only if natural and legal laws complement each other that a consistent and uniform order of the economy can be attained."[1] From its knowledge of the nature of the economic laws and from the conditions of the historical environment, economic science is able to indicate the direction in which the required coordination has to be sought. There are, however, in this basic direction a whole host of possibilities of shaping practical policies among which science cannot make a binding choice. This is the task of those engaged in economic policy. Economic policy is usually a compromise between a certain insight into the true relationship of the facts and forces involved and the wishes of the voters who elected the party (or parties) in power. Science can help in appraising a given situation by presenting in a systematic order the measures of economic policy carried out in the past and by investigating their consequences. Thus it will be revealed whether the objectives were reached, how great were the costs involved, and whether or not any immediate success was offset by unintended side-effects and retroactions. From such analysis the statesman gains new insight as to where State intervention can be correctly applied and what its limits are. This results in a theory of economic policy for practical use. The Italian economist, C. Bresciani-Turroni, has written an excellent book on this subject.[2] The main direction of agricultural policy thus being found in connection with political value-judgments and the inherent economic laws (point 1 and 2 of our program), the third task, i.e., coordination with general economic policy, and the fourth task, i.e., adequate harmonization of all measures of agricultural policy, cannot be of great difficulty. Therefore, it is on the first two tasks that we will now concentrate our full attention.

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[1] *Leonhard Miksch,* Die sittliche Bedeutung der inneren Koordination (Moral Significance of Inner Co-ordination). In: Ordo, Vol. 3, 1950, p. 6

[2] *Constantino Bresciani-Turroni,* Einführung in die Wirtschaftspolitik. (Introduction to Economic Policy). Berne, 1948.

After the war the German people decided for the democratic constitutional State, in which the basic rights of the individual are to be harmonized with the public interest through a legal order. *The legal order guarantees the use of freedom, but also limits it. The ideal "norm," therefore, is an equilibrium between the principle of freedom derived from the ethics of the individual, and the principle of justice, belonging to the ethics of society.* Obviously, this equilibrium cannot be expressed by a fixed formula. In its concrete form it depends on the understanding and the good will of those who govern and those who are governed. The more those who are governed conceive of their freedom as an application of ruthless egoism, the stronger the barriers against individual arbitrary action must be. Accordingly, the logical and moral foundation of genuine democracy is civic education and practical experience in self-government of local and regional administrative units in which companionship of all classes of the population in every day life develops the feeling for a just compromise of interests. Those who govern, however, have to guard against a misuse of their authority by wisely limiting legislation and by using administrative orders and their enforcement through administrative measures as little as possible. The point is, therefore to find an economic system which realizes a maximum of freedom and justice. If the economy had to be directed solely through laws and administrative orders, the cause of freedom would be in a bad state. In fact, freedom is supported by a principle of order inherent in the economy which is based on the nature of man and things and keeps the complicated economic process moving hourly and daily.

Similarly as all chemical processes can be reduced to the manifold combinations of relatively few elements of determined affinities economic life, in which many millions of firms and households make their plans, is subjected to an order by the fact that all those participating have again and again to decide on the use to make of scarce means in accordance with a few easily understandable rules. The driving force is based on the nature of men who—as Adam Smith has pointed out—all want to improve their lot; it is based on technical imagination through which man so much differs from the animal which remains in passive adaptation to its surroundings; finally it is based on the observance of the economic principle, i.e., to employ on a thing only as much time and effort as is unavoidable. Thus originated the division of labor and the exchange of goods and services, which obtain their money value in the market, the latter functioning as regulator for production and consumption. *This co-ordination through the market of the individual economic units, which are engaged in mutual activities for each other, creates, in accordance with the law of large numbers, an order of relationship which is of compelling significance for all those who participate.* It is similar to the bee-state where neither king

nor queen nor a parliament of working-bees is in command, but where, nevertheless, an order insuring existence is provided by the harmonization of functions. The only difference is that in the human economic system the unconscious natural instinct has been replaced by conscious, intelligent adaptation.

From the daily and hourly plebiscite of the consumers, who are guided in their households by their utility estimates and thus determine the direction and volume of demand in the market, impulses are going out to the firms, which adjust their production accordingly. The firms, through the competitive demand for means of production (labor, capital, and land), determine, in accordance with the law of large numbers, the market prices of these items and simultaneously their individual costs of production. They attempt to bring these in such a relation to their receipts that the profit reaches a maximum. From the participation in this process of production income arises for all concerned; this income, in turn maintains production through both its expended and saved parts. In a stationary, not expanding economy, the whole process would take its course in perpetual uniformity according to a fixed routine. It would stay in a position of stationary equilibrium. In reality, however, the economic process differs from the natural order because, although it too always recurs, it runs with increasing mastery of nature on a rising technical level and in an expanding volume and increasing complexity. Thus occidental man in particular built over nature the artificial structure of his economy, which permits him to satisfy his increasing wants through a continuous accumulation of his resources and through their intelligent utilization.

This dynamic character of the economy, however, causes a decisive change in the plans of the individual economic units and the households: for now it is only within a limited scope that people are able to rely on the well-trodden paths of routine. As the data of the economic and social environment are continuously changing, plans have to be based on future expectations. Consequently the possibility of error and the consequent risk is introduced into the economic process. It can be covered through recourse to accumulated funds, through reserves in industry, through household savings or through anticipation of future income in the form of credit. *Error and risk, however, are the necessary counterpart to freedom of choice in all human actions based on future expectations.* If they were subject only to chance, then they would offset each other in accordance with the law of large numbers and not have any influence on the total course of economy. In fact, however, they are subject to the law of contagion as a result of the human gregarious impulse. They accumulate in certain directions to collective mistakes, which may lead to disequilibria in the commodity, capital, money and labor markets. Thus the peri-

odic fluctuations of the business cycle arise, whose small likeness in the pig-cycle is particularly familiar to farmers. But the price mechanism of the market, which always compels adaptation, fetches the economy back from its extreme positions. An equilibrium is never reached, but the national economy advances even though some individual units which do not adapt themselves in time suffer losses or even perish.

In this respect, the competitive market economy corresponds to the unsentimental principle of nature, for which primarily the survival of the species and not that of the individual matters. The humanitarian principle which protects the backward and the weak ones, has its legitimate place in human society as social policy and charity in addition to, but not within the market economy. Elevated to a principle of the market economy, it would disturb the flexible mechanism of price relations and diminish the efficiency of the whole economy. In the permanent struggle in which mankind wrests from nature the always scarce goods for the satisfaction of wants one should not transfer the hospitals to the front-line. But one may use financial and central bank reserves in particular danger areas in order to prevent deep penetrations of the economic structure, but without removing the entire risk from the individual units.

Provided that in the system of a competitive market economy there are only individuals of equal political power and there exist no differences of property on which economic predominance is founded, an economic order based on the principle of efficiency, supervised by a careful policy moderating fluctuations and supplemented by social policy and charity, can realize a high degree of freedom and justice. But here we have to make an important qualification. The order of human society does not depend only on the co-ordination of individuals in an equal economic position who exchange goods and services in the market. It serves no purpose to close one's eyes to the fact that since its very beginning social life has been also characterized by relations based on power. Power, however, establishes its own system of order; it consists in "a network of predominance in which each element promotes and equally controls the activity of the elements sub-ordinated to it."[3] Here we are confronted with a principle of subordination, in which the minority, the elité, is calling the tune. The history of this hierarchy of power is characterized by the succession of elités. In the Middle Ages the socio-political system was determined by the nobility and the church; then followed the absolute rulers with their bureaucratic and military hierarchy; afterwards the grande bourgeoisie won a share of power in the constitutional monarchies and sole power in the republics. In the parliamentary democracy it granted

[3] *L. L. Whyte,* Die nächste Stufe der Menschheit. (The Next Step of Mankind). Zürich, p. 141.

political equality, but simultaneously founded its hierarchy of power on the ownership of real and monetary capital. But the rotation of elités continued because in this world nothing is lasting but change. As the nobility in the constitutional monarchies had to share its power with the bourgeoisie, today in the Western democracies the industrial workers and farmers are participating in political power.

Undoubtedly never before in the course of world history has been realized so much freedom in human society as in the present-day systems of Western democracy. All the more reason why we should be careful lest we fall. The vast dispersion of power is able to guarantee a high degree of freedom and justice if the participating groups possess a great sense of responsibility, but is leading to struggles of power and economic strife of an oligopolistic nature if the elités are of lower quality. In this case the State becomes a prey of group anarchy and in the economy the principle of efficiency of the competitive market economy is replaced by a system of privileges for a few powerful groups, which, pretending that the system of free competition is unsuitable for them, use the State as a mechanism for intervention in order to secure for themselves as large a share of the national product as possible. Group anarchy, however, creates a political vacuum which is never tolerated by history. When there are no longer any elité responsibly representing the common interest, power necessarily shifts from the groups of parliamentary democracy to the bureaucratic police state, which then will press the economy into a centrally-planned system (Zentrale Verwaltungswirtschaft) and will abolish freedom.

To understand this danger fully, we have to pursue more deeply the analysis of the historical environment and to discuss a modern trend in mass psychology which I should like to call "the security complex." For here are to be found the deepest roots of the distrust of the laws of competitive market economy. This craving for security, which today is making so many people inclined to trade their freedom for a "mess of pottage," has been particularly fostered by the fear neurosis, which the Great Depression of 1929-33 has left behind. That crisis is different from all previous ones through its geographical extension, its vehemence and long duration; for in many countries the depression still lasted when World War II broke out despite many forced cures attempted by economic policy. *Now it has to be emphasized that there is no greater falsification of history than the attempt to blame the competitive market economy for this catastrophe.* This legend is an attempt at exoneration by the politicians, who since the beginning of the 20th century have plunged their people into misfortune through their miserable policies. They drove the

economy through two world wars and even more inflations, destroyed the ingenious mechanism of the gold standard, threw the balances of payments over through the anti-economic mechanism of political indebtedness, made a medley of all quantities and prices, used penal law as guarantor of their new economic order, and finally invented a thousand protheses for the mutilated economy. And now that the economy has recovered in spite of the barbarous cures thanks to the will to survive and to the industry and intelligence of many million individuals, these millions are still kept in the belief that their salvation has been due to the crutches of interventionism and that only with their aid will they be able to enter a safe path into an unknown future. Strained by an immense burden of taxation, they see in every normal fluctuation of market prices at once the ghost of a new economic crisis. Without realizing that the competitive market economy was thoroughly corrupted through bad policy, their view is so dangerously distorted that they expect security through liberation from the market risk! As only recently I was told by a high official, one does not want to be pressed into the competitive market economy, but wishes to bring about freedom and order through marketing regulations by the State. Thus the confusion is complete: It is no longer possible to differentiate between freedom and compulsion, the words remain only as arbitrary labels. How should it be possible to conduct an economic policy based on a uniform principle if such a Babylonian confusion of tongues prevails? Clarification of fundamental concepts is, therefore, urgent.

As early as 1948 I have pointed out[4] that it is only possible to understand the problem of freedom and security if one descends from general concepts to the specific freedoms and securities people are striving for in everyday life. I do not fear to be contradicted when I assert that e.g. the farmer would like to enjoy the following freedoms: freedom to dispose of his farm through legal action (contract with his children, last will, sale, mortgaging), freedom to organize and operate the farm as he pleases and to sell his products to whom he will. But he also wants to enjoy the following securities: security against expropriation, foreclosure, excessive taxation; assurance of a permanent sale of his products at acceptable prices which are subject only to minor fluctuations. It can be easily demonstrated that these freedoms and securities cannot always be realized simultaneously and that a decision is required as to which specific freedoms should be exchanged for which specific securities. Freedom and

[4] *H. Niehaus,* Der Bauer in der Wirtschafts- und Gesellschaftsordnung. (The Farmer in the Economic and Social System), Köln und Opladen, 1948.

security thus being divisible, everyone can arrive at a special combination according to his situation and his scale of values. In 1933 e.g. many heavily indebted farmers were prepared to accept the stringent restrictions upon the freedom to dispose of the farm, which were contained in the National Socialist law on peasant inheritance (Reichserbhofgesetz), in order to escape foreclosure. During the period of scarcity between World War II and 1950 farmers sympathized with free economy and competition, removal of controls and abolition of the government-controlled, compulsory organization of German agriculture from 1933-1945 (Reichsnährstand). After the markets became more plentiful the majority has decided again for the marketing regulation and many would like to see the Reichsnährstand re-established. That's the way in this country and that country all over the world and in all branches of economic activity. Those who feel themselves strong cherish the free play of economic forces, those who feel themselves inferior seek aid for the defense of their position—price supports, tariff walls or similar devices.

Of late, American economists have also made investigations on this interaction of freedom and security and have arrived at the same conclusions.[5] Hathaway, for instance, sees the difficulties of United States agricultural policy in the fact that the ideas of the farmers and the Government on the proper rate of substitution to be chosen between freedom and security have seldom been in agreement. His suggestion, however, that one should determine the farmers' opinion through conducting interviews so that the Government may know "whether a given program would be acceptable to farmers" would mean abandonment of a constructive agricultural policy, based on the public interest, in favor of the interests of a single occupational group. *The short-term balance of freedom and security corresponds only to the current interest of the majority of the members of an occupational group.* It has, therefore, to be supplemented by an economic and social balance sheet of the whole national economy in which are to be entered the liabilities arising through undesired repercussion of the policy of intervention in the occupational group concerned itself and directly and indirectly in other segments of society. Wherever the apparatus of the State is set in motion in favor of a particular occupational group with the defensive call for more security, a characteristic change in attitude can be observed. The more one has, the more one wants. Having screened oneself off against the risk, one becomes offensive and tries to obtain for oneself a larger share of the national

[5] *D. E. Hathaway*, "Agricultural Policy and Farmer's Freedom: A suggested Framework," *This Journal*, Vol. 35, No. 4, November 1953, pp. 496-510. *E. G. Long*, "Freedom and Security as Policy Objectives," *This Journal*, Vol. 35, No. 3, August 1953, pp. 317-322.

product at the expense of others. *Thus the principle of collective securities is revealed as the method of popular greed and cleverness:* to throw a sprat in order to catch a salmon the size of which one determines through calculations of cost, wage quotas or "parities." The whole substance of economic policy then becomes a struggle over the share in the national product, decided not by economic efficiency but by the concentration of political power. Thus the real meaning of the economic system, which should be a common arrangement for the satisfaction of human needs, is falsified. Today anyone in harmless sheep's clothing who is clamoring for security ought to be grasped below his skin to make sure it does not conceal a wolf.

Historians and economists are able to prove from the course of history and from the knowledge of the economic laws *that the competitive market economy contains indispensable elements of a liberal and just order but that these elements have to be protected and perfected by the legal order of a strong State:* by a State which restrains individual and group egoism and does not lower itself to be the willing servant of pressure groups. The last twenty years have shown that economic policy was not much concerned to include the inherent laws of the economic process into a general social order, but rather attempted to push them back and to place itself in open opposition to them. Since, however, as is pointed out by Bresciani-Turroni, there are spontaneous economic forces which it would be neither possible nor feasible to suppress, the market mechanism remains effective as directing factor to some degree. Thus rather confused mixed systems originate in which interventions are often applied at isolated points (punktuell), i.e. without due regard to the relationship of the economic process, and thus create new disturbances. Consequently, in the words of Franz Böhm, arises "a playground for continuous pushing –indifferent to any order–an anarchy of group licentiousness, an altogether amorphous social process and consequently the ideal soil for those who mistake mere fussiness for political action."[6] *Order can be brought out of this confusion only by selecting interventions in such a way that they harmonize with the laws of competitive market economy.*

In the findings of the Committee on Agricultural Marketing Order[7] we have tried to distinguish interventions according to their conformity or nonconformity with the principles of the competitive order of the economy. This gives the following list, which I am supplementing in a few points:

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[6] *Franz Böhm,* Die Idee des Ordo im Denken Euckens (The Concept of Ordo in the Thought of Walter Eucken) In: Ordo:, Vol. III, 1950, p. XXXV.

[7] Gutachten A des Ausschusses für landwirtschaftliche Marktordnung edited by the Bundesminister für Ernährung, Landwirtschaft und Forsten, Bonn, March 1950.

1. *Objectives and methods of price and marketing policy nonconforming with the competitive order of the economy.*
   (a) The objective to cover the costs of all producers.
   (b) All attempts to achieve price and income parities through interventions in the market.
   (c) Government price supports which attempt to keep the price level permanently above the market price and lead to the accumulation of unsalable stocks and finally to compulsory interferences with production.
   (d) Pushing down of prices below the market price for social reasons. Social policy is to be conducted not through interferences with the market, but through direct grants.
   (e) Price fixing through trade associations and monopolies formed by vested interests.
   (f) Government import monopolies, rigid import quotas and foreign-exchange control.
   (g) Bilateral balancing of foreign trade, which either hampers exports or makes imports necessary which otherwise would not be made.
   (h) Regionalism, i.e. union of several states in regard to trade policy with strong isolation from the rest of the world. Instead of two partners as is the case with bilateralism, several partners are now caught in the cage.
   (i) Far-reaching authorizations of Governments or individual departments for intervention in the market. They are desultory, unforeseeable, are under the pressure of vested interests and give too much scope for arbitrary actions to subordinate offices.

2. *Objectives and methods conforming with and supplementing the competitive order of the economy.*
   (a) Marketing rules (Marktordnungen) as distinguished from market regimentations (Marktregelungen) designed to ensure a well-functioning price mechanism and to promote competitive efficiency, e.g. establishment of markets and exchanges, correct price quotations, assembly and dissemination of market information, efficient and reliable statistics, sanitary minimum demands, establishment of standard qualities.
   (b) Moderate protective tariffs which lessen, but do not cancel, the effect of international competition on the location of industries and which should be slowly reduced when the competitive strength of the protected industry has been increased.
   (c) Government stocks, limited to the minimum, for smoothing out

violent price fluctuations in agricultural products the demand for which is inelastic.

(d) Prevention of the emerging of strong monopolies, best achieved through a radical reduction of duties on monopolized goods.

(e) Defence measures against foreign trade monopolies of other countries, against dumping with the help of low exchange rates, and against price dumping by foreign private monopolies.

(f) Measures for reclamation and soil improvement and for the improvement of the social structure, directly financed from the budgets of the states and the Federal Republic in order to give greater competitive strength to weak participants in the market.

(g) A money, credit and finance policy which—alternatively applied as a "brake" and as an "accelerator"—reduces the amplitudes of the business cycle and thus results in a stabilizing effect.

A glance at this list shows that an economic policy which is based on the laws of the market economy and renounces non-conforming interventions, retains nevertheless a wide scope for its activities; and that the competitive market economy, as we understand it, is entirely different from the bugbear of the free play of economic forces, with which the confirmed planners always frighten people. The study of our list, however, forces also another insight upon our minds. *Many of the measures enumerated support and supplement the competitive system if used in moderate doses, but interfere with it if the dose becomes too strong.* Economic policy is, therefore, faced with the same problems as medical therapy in using medicines. Provided they are given in small quantities a stimulating effect is obtained by the same drugs which in too large a dose poison the body. It can be shown by many examples that *overdosage of interventions has become the typical disease of the economy in our time.* Import monopolies are likewise continuously inclined—influenced by the domestic producers—to choose the upper price limit and to render difficult the absorption of the commodity by the market. Although an active policy for influencing the business cycle may be a stabilizing factor through cautious application of its instruments, it is leading to inflation under the reign of the dogma of full employment and of a naive purchasing power theory. A moderate protective tariff is compatible with the competitive system, a high tariff has the same distorting effects on foreign trade as have quotas and import monopolies. Stockpiling, especially of agricultural products with inelastic demand, may lessen price fluctuations, but its overdosage paralyzes the automatic forces of adaptation and places too high demands on the treasury. *Economic policy as art of the possible, therefore, is primarily the art of moderate and intelligent dosage.* First

of all, this requires a large measure of independence from the wishes of vested interests. This applies to all fields of economic policy. With respect to agricultural policy I have formulated the problem in another place as follows: "The wishes and demands submitted to the legislator and the administration by the organized interests are 'raw materials' and driving forces from which the discernment of Parliament and the impartiality of public administration have to create a final product which deserves the name of agricultural policy."[8]

In view of the confusing debate on the problem of competitive market economy and interventions, it is worth quoting Minister Dr. Erhard who in spite of all objections, made the theoretical model, constructed by the economists Eucken, Böhm and Miksch, the guiding principle of his economic policy. At the meeting of the Volkswirtschaftliche Gesellschaft (Economic Society) in Hamburg on January 7, 1954[9] he said: "If I declare myself with such obstinacy . . . in favor of the principle of the market economy, it has its good reason. Of course, I know that the theoretical model of pure competition is not entirely valid on this or that point. Nevertheless we should thank God that we possess again such a theoretical model, thus at last have returned to a thinking in terms of economic order and have given up 'muddling through' . . . I believe that we owe the success, which we can claim, to the model of an economic order, which we carry in our heads, although we were prepared and had to be prepared to deviate from it in details."

Reconstruction of the German economy has taken place in line with this fundamental concept resulting in a decided turn away from the centrally planned system, the complete collapse of which had left the national economy in a chaotic condition. If it needed a convincing proof that strength is characteristic even of a very imperfect competitive market economy, this proof has been furnished in the last few years. This gives encouragement to realize gradually the competitive system in the long-run even in those fields of economic activity where it is not yet functioning satisfactorily—in the markets for iron and steel, in a number of agricultural markets, in housing, in the field of foreign exchanges, and in foreign trade. The practical way is (1) to abolish overdosage in many of the market regulations still existing and (2) to shift from interventions inimical to competition to measures perfecting it. If one keeps this goal before one's eyes, then the only other thing that matters is the choice of the right moment for action. In this respect, however, economic theory

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[8] *Heinrich Niehaus*, Agrarpolitik, volkswirtschftlich-politische Problematik. In: Handwörterbuch der Sozialwissenschaften, Stuttgart, Tübingen, Göttingen 1953. p. 85.

[9] *Grosse, Mommsen, Wessel,* Der Wettbewerb in der Grundstoffindustrie (Competition in Raw Materials Industries) Darmstadt 1954, p. 108.

cannot make any binding statements. This is a matter for born statesmen who possess what Spengler has called "physiognomic tact." On the one hand, they have to overcome the inertia, which is a direct consequence of the security complex of the masses, and, on the other, to check the zeal for action shown by the bureaucracy of state and administration, for whom intervening has become a life-work. Operating along this basic course would also harmonize agricultural policy with general economic policy and give it a clear systematic principle for its specific measures.

THE IMPACT OF URBAN-INDUSTRIAL DEVELOPMENT ON AGRICULTURE IN THE TENNESSEE VALLEY AND THE SOUTHEAST*

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I. *The Income of Both Farm and Nonfarm Families is Closely Related to Urban-Industrial Development*

THE close relation between economic development and the growth of the urban-industrial sectors of the economy has received increasing attention in recent years. In its most general form, this relationship is implied in the well-known Clark-Fisher hypothesis:

> In every progressive economy there has been a steady shift of employment and investment from the essential "primary" activities, without whose products life in even its most primitive forms would be impossible, to secondary activities of all kinds, and even to a still greater extent into tertiary production.[1]

T. W. Schultz has stated the relationship somewhat more precisely in a series of three hypotheses:

> (1) Economic development occurs in specific locational matrix; there may be one or more such matrices in a particular economy . . . (2) These locational matrices are primarily industrial-urban in composition . . . (3) The existing economic organization works best at or near the center of a particular matrix of economic development and it also works best in those parts of agriculture which are situated favorably in relation to such a center . . .[2]

If the effectiveness of the existing economic system can be measured by its ability to produce income, there can be little doubt that these hypotheses are consistent with the general pattern of economic development in the United States.

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[1] Allan, G. B. Fisher, *Economic Progress and Social Security* (London: 1945), p. 6. See also, Colin Clark, *The Conditions of Economic Progress* (London: 1940).

[2] T. W. Schultz, "The Economic Organization of Agriculture," (New York, McGraw Hill, 1953), p. 147. See also Schultz's article, "A Framework for Land Economics—the Long View," *Journal of Farm Economics*, vol. XXXIII (May 1951), pp. 204-15.

A number of investigations, based largely on data available prior to publication of the 1950 censuses of *Population* and *Agriculture*, tend to substantiate the hypothesis that *the level of income achieved by nonfarm families and individuals in any given area is closely related to the level of urban-industrial development in the same general area.*[3] In his study of "Factors Influencing State Per Capita Income Differentials," Fulmer pointed out that "the best single index of a region's or state's economic development is the extent of urbanization."[4] In an investigation of "Some Effects of Region, Community, Size, Color and Occupation on Family and Individual Income," Johnson concluded that "incomes of (nonfarm) white families in the South are approximately the same as for the rest of the nation if the influence of community size is eliminated."[5]

Analysis of data from the *1950 Census of Population* indicates that variations in the level of local urban-industrial development, as measured by the percent of the population that is *nonfarm,*[6] continues to be asoci-

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[3] See for example, Herbert E. Klarman, "A Statistical Study of Income Differences Among Communities," *Studies in Income and Wealth,* vol. 6, National Bureau of Economic Research, New York (1943), pp. 206-235; John L. Fulmer, "Factors Influencing State Per Capita Income Differentials," *Southern Economic Journal,* XVI (January 1950), pp. 259-78; S. C. Sufrin, A. W. Swinyard, and F. M. Stephenson, "The North-South Differential—A Different View," *Southern Economic Journal,* XV (October 1948), pp. 184-90; Louis H. Bean, "International Industrialization and Per Capita Income," *Studies in Income and Wealth,* vol. 8, National Bureau of Economic Research, New York (1946), pp. 119-141; D. Gale Johnson, "Some Effects of Region, Community, Size, Color and Occupation on Family and Individual Income," *Studies in Income and Wealth,* New York: National Bureau of Economic Research, vol. 15 (1952), pp. 51-75.

For comments on the above studies, see Henry M. Oliver, Jr., "Income, Region, Community-Size and Color," *Quarterly Journal of Economics,* vol. LX (August 1946), pp. 588-99; Harold F. Breimyer, "Some Comments on Factors Influencing Differences Between State Per Capita Incomes," *Southern Economic Journal,* XVII (October 1950) pp. 140-7; John L. Fulmer, "Reply to Breimyer on State Per Capita Income Differences," *Southern Economic Journal,* XVII (April 1951), pp. 470-7; Jesse W. Markham, "Some Comments Upon the North-South Differential," *Southern Economic Journal,* XVI (January 1950), pp. 279-83; J. M. Buchanan, "Note on the Differential Controversy," *Southern Economic Journal,* XVII (July 1950), pp. 49, 60; Jesse W. Markham, "The North-South Differential—A Reply," *Southern Economic Journal,* XVII (January 1951), pp. 339-41; Herman P. Miller and Edwin D. Goldfield, "Some Effects of Region, Community Size, Color and Occupation on Family and Individual Income: Comments," *Studies in Income and Wealth, op. cit.,* pp. 70-72.

Most of the comments object to the overemphasis of community size as compared to regions rather than to the hypothesis that community size is one of the factors associated with income differentials. For example, Oliver, *op. cit.,* states "complete rejection of the regional thesis is as mistaken as complete passing over of the relationship between income-height and community-size, . . . income differentials among regions, as well as among communities of varying size are significant." (p. 595)

[4] Fulmer, *op. cit.,* p. 266.

[5] D. Gale Johnson, *op. cit.,* p. 51.

[6] Use of the percent of the total area population nonfarm as an index of the relative level of urban-industrial development appears to have some advantages over definitions based on (a) absolute size of nonfarm or urban population, or (b) distance from

ated with a substantial share of the variations in the median income of *nonfarm* families. The coefficient of correlation (r) between the median income of nonfarm families and the percent of the population that is nonfarm for the states of the United States is .66 (see table 1). The comparable figure for state economic areas in the Southeast is .69 and for counties in the Tennessee Valley, .75.

There appears to be fairly general agreement, then, in spite of a few dissenting voices, regarding the relationship between over-all economic development and local urban-industrial growth. There has not, however, been the same level of agreement—or investigation—with respect to the proposition mentioned by Schultz in this third hypothesis: "The existing economic organization works best . . . in those parts of agriculture which are situated favorably in relation to such a (urban-industrial) center."[7, 8]

Examination of data from the *1950 Census of Population* indicates that at the present time, in both the Tennessee Valley region, the Southeast, and the nation as a whole, *the (median) income level achieved by rural-farm families (from farm and nonfarm sources) does bear a direct and a positive relationship to the relative level of urban-industrial development*

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selected urban concentrations in that it is a relative measure and in that it is better adapted to handling differences in the size of the area considered (states, state economic areas, or counties). See Kingsley Davis and Hilda Golden, "Urbanization and the Development of Pre-Industrial Areas," *Economic Development and Cultural Change,* III (October 1954), pp. 6-24.

[7] Schultz, *op. cit.,* p. 147.

[8] Most discussion of the relationship between agricultural and industrial development has dealt with the role of agriculture as a factor in the location of industry. Research in this area would tend to support the hypothesis that the regional distribution of agricultural activity largely determined the location and type of industrial activity in pre-industrial societies, but that this relationship has largely disappeared in areas which have felt the effect of the industrial revolution. (See for example, "Food and the Location of Economic Activity," in Pei-kang Chang, *Agriculture and Industrialization,* Cambridge: 1949, pp. 28-30; Bowden, Karpovich, and Usher, *An Economic History of Europe Since 1750,* New York: 1937, pp. 4-5; S. H. Robock, "Rural Industries and Agricultural Development," *Journal of Farm Economics,* XXXIV, August 1952, pp. 346-60). Among the studies dealing specifically with the impact of local urban-industrial growth on agriculture in the same area are A. W. Ashby, "The Effect of Urban Growth on the Countryside," *The Sociological Review,* vol. XXXI (October 1939), pp. 345-69; L. A. Parcher, "The Influence of Location on Farmland Prices," Oklahoma Agricultural Experiment Station Bulletin No. B-417, Stillwater: March 1954; J. M. Stepp and J. S. Plaxico, "The Labor Supply of a Rural Industry," South Carolina Agricultural Experiment Station Bulletin #376, Clemson: July 1948; Francis E. McVay, "Factory Meets Farm in North Carolina," North Carolina Agricultural Experiment Station Technical Bulletin No. 83, Raleigh: October 1947; and C. E. Bishop and J. G. Sutherland, "Resource Use and Incomes on Small Farms, Southern Piedmont Area," North Carolina Agricultural Experiment Station, AE Information Series 30, Raleigh: February 1953. Except for the studies by Bishop and Parcher, these studies are, however, concerned almost entirely with the impact on farm population and resources which shift from the farm to the nonfarm category rather than the impact on population and resources remaining in agriculture.

TABLE 1. THE RELATIONSHIP BETWEEN THE MEDIAN INCOMES OF NONFARM FAMILIES AND UNRELATED INDIVIDUALS IN 1949 AND THE PERCENT OF TOTAL POPULATION NONFARM IN 1950 FOR SELECTED AREAS*

Area	Equation[a]	Coefficient of: Correlation	Coefficient of: Determination	Standard Error	F Ratio[b]: Computed	F Ratio[b]: Critical
U.S. (48 States)	$I_1 = 817.25382 + 27.44437X$	.659	.434	$364.72	37.03	4.068
U.S. (41 States)[c]	$I_1 = 58.44549 + 35.65931X$	.790	.624	314.03	67.27	4.089
Southeast (104 State Economic Areas)	$I_1 = 672.10304 + 17.32401X$	.694	.481	292.11	96.44	3.944
Tennessee Valley Region (201 Counties)	$I_1 = 622.41862 + 18.67613X$	.749	.562	295.05	257.42	<3.92

TABLE 2. THE RELATIONSHIP BETWEEN THE MEDIAN INCOMES OF NONFARM FAMILIES AND UNRELATED INDIVIDUALS AND THE MEDIAN INCOMES OF FARM FAMILIES AND UNRELATED INDIVIDUALS IN 1949, FOR SELECTED AREAS*

Area	Equation	Correlation	Determination	Standard Error	Computed	Critical
U.S. (48 States)	$I_2 = -1452.07861 + 1.14763I_1$	.89	.797	$280.94	181.51	4.068
Southeast (104 State Economic Area)	$I_2 = 262.69368 + .46749I_1$	.545	.297	288.19	44.55	3.944
Tennessee Valley Region (201 Counties)	$I_2 = 355.38343 + .44761I_1$	.697	.486	204.23	190.43	<3.92

TABLE 3. THE RELATIONSHIP BETWEEN THE MEDIAN INCOME OF FARM FAMILIES AND UNRELATED INDIVIDUALS, 1949, AND THE PERCENT OF TOTAL POPULATION NONFARM, 1950, FOR SELECTED AREAS*

Area	Equation	Correlation	Determination	Standard Error	Computed	Critical
U.S. (48 States)	$I_2 = -289.86123 + 28.71894X$	.53	.282	$527.22	19.43	4.068
U.S. (41 States)[c]	$I_2 = -1749.41241 + 44.63575X$	.81	.650	371.06	75.37	4.089
Southeast (104 State Economic Area)	$I_2 = 342.13014 + 11.72888X$	.55	.303	286.98	45.83	3.944
Tennessee Valley Region (201 Counties)	$I_2 = 515.55245 + 10.86746X$	.68	.463	208.80	173.66	<3.92

[a] I_1 = Median Income of Nonfarm Families, 1949; I_2 = Median Income of Farm Families, 1949; X = Percent of Total Population Nonfarm, 1950.
[b] Critical values of F are at the .05 level of significance and indicate that the hypothesis—that there is no relationship between the two variables—should be rejected.
[c] Excludes Northern Great Plains States—Idaho, Montana, Wyoming, North and South Dakota, Iowa and Nebraska.
* Income data used in these relationships are for families only for the states of the U.S. and for families and unrelated individuals for counties and state economic areas.
Source: Basic data compiled from *U.S. Census of Population, 1950*, vol. II, *Characteristics of the Population.*

in the same general area. In the areas studied the median income of *farm* families is almost as closely related to the percent of the total population that is nonfarm as is the median income of *nonfarm* families (see tables 1, 2 and 3).[8a]

While this relationship seems generally valid for most areas of the nation, the analysis does not support the conclusion that high levels of income in rural areas cannot be achieved without extensive local urban-industrial development or that extensive local urban-industrial development necessarily results in high levels of rural income. At the state level, we have the example of seven high-income northern Great Plains states where there is apparently little or no relationship between the median incomes of farm families and the intensity of local nonfarm development. Indeed, for the Northern Great Plains area, there seems to be some evidence that the level of income achieved by nonfarm families is a function of the level of income achieved in the agricultural sector.[9] For the state economic areas of the eleven southeastern states and the 201 counties of the Tennessee Valley region, there are no extensive areas which stand as clearly outside the general pattern as the Northern Great Plains states do in the national picture.[10] Only a few isolated areas, such as the Mountain counties of northeastern Georgia (economic area 2), the southeastern

[8a] D. Gale Johnson has suggested (in a letter) that the similar relationship between both the median incomes of nonfarm families and the median incomes of farm families and the percent of the population that is nonfarm may be due to the concentration of non-white families in areas that are least urbanized. An examination was made of the dot diagrams between (a) median income of *white nonfarm* families and unrelated individuals and the percent of the population that is nonfarm; (b) the median income of *non-white nonfarm* families and unrelated individuals and the percent of the population that is nonfarm; (c) the median income of *white farm* families and unrelated individuals and the percent of population that is nonfarm; and (d) the median income of *non-white farm* families and unrelated individuals and the percent of the population that is nonfarm for the 16 southern states for which data on the median incomes of non-white families are available. All of the relationships appear to be strongly positive. Thus, while the concentration of non-white population in the least urbanized areas may be one of the factors involved in accounting for the above relationship (see tables 4 and 5 and pp. 9 and 10), the evidence would seem to indicate that a strong positive relationship between the percent of the population that is nonfarm would continue to exist even after the influence of the non-white population is removed.

[9] This conclusion is based (a) on the fact that the median income of nonfarm families is much less closely related to the percent of the total population that is nonfarm in the northern Great Plains than it is in the rest of the U.S. (figure 1), and (b) on the close relationship between the median incomes of urban and rural nonfarm families and the median income of rural farm families (figure 2).

[10] The data presented in tables 1, 2 and 3 indicate that the relationship between the median income of rural farm families and unrelated individuals and the percent of total population nonfarm is generally not as close at the state economic area level as at either the state or the county level. This would tend to cast some doubt on the usefulness of the state economic area as an appropriate unit for the analysis of factors influencing income differentials.

Virginia Tidewater area around Norfolk and Newport News (economic area 9), and the area around Memphis, Tennessee (Shelby County), diverge sharply from the general pattern.

The fact that welfare levels in agriculture, as measured by the median incomes of farm families, are generally higher in those areas of the nation and the Southeast where urban-industrial development has advanced the farthest increases one's confidence in the Schultz "impact hypothesis." Simple correlations of this type do not, however, tell one very much about (a) why the agricultural sector of the economy does perform more effectively in areas of advanced urban-industrial development, or (b) through what channels the interactions between the urban-industrial and the agricultural sectors of the economy take place.

In general, the interactions between the farm and nonfarm sectors of the economy can be expressed in terms of four sets of market relationships: (a) *the labor market*—through which labor is allocated as among agricultural enterprises and between the agricultural and the nonagricultural sectors of the economy; (b) *the capital market*—through which purchases of capital assets and current working capital are financed; (c) *the product market*—the market(s) for the products produced by agriculture; and (d) *the current-input market*—the market(s) for current inputs consumed in the process of agricultural production.

In the following sections of this paper an attempt will be made to determine the relative magnitude of the influences which urban-industrial development exerts on the incomes of farm families and farm workers in the Tennessee Valley region through each of these markets. The analysis will involve the use of correlation and regression techniques and the analysis of variance. These techniques will be employed to determine the impact of factors associated with each of the four markets on variations of the median incomes of farm families (from all sources) and the average incomes of farm workers from farming. This analysis depends for its validity on a normal distribution of median incomes among counties. The analysis will, therefore, be limited by the extent to which the assumption of normality is violated.

II. *Major Impact of Urbanization on Farm Family Incomes Exerted Directly Through the Labor Market*

In an area such as the Southeast, including the Tennessee Valley, it seems reasonable to suspect that *the major income effects of local urban-industrial development are transmitted to the agricultural sectors of the local economy through the labor market.* This hypothesis rests on four observations:

1. *Rapid Decline in Farm Labor Requirments*—A combination of rapid

technological advance, the substitution of land, nonland capital inputs and current inputs for labor, coupled with the relatively low income elasticity of demand for the major farm products produced in the region has permitted a substantial decline in labor inputs in southeastern agriculture over the last two decades.[11]

2. *Insufficient Growth of Nonfarm Jobs*—Although urban-industrial development occurred at a more rapid rate in the Southeast, including the Tennessee Valley region, than anywhere else in the nation except the Far West during the 1940-50 decade,[12] the expansion in nonfarm employment was not sufficiently rapid to absorb much more than two-thirds of the new entrants to the nonfarm labor force (a) from the younger age groups, (b) from workers leaving agriculture, and (c) from the backlog of unemployment which existed in 1940.[13]
3. *Reluctance to Migrate*—Even though large declines in farm employment have occurred in recent years, substantial underemployment—measured in terms of either average or marginal labor productivity—continues to exist in most sectors of southeastern agriculture. The greater reluctance of low-income farm families and workers to migrate substantial distances than to accept local nonfarm employment[14] has tended to concentrate the greatest underemployment in areas farthest from urban centers.
4. *Institutional Barriers to Migration*—In spite of heavy outmigration from the Southeast to other areas of the nation and heavy rural-urban migration within given labor market areas in the Southeast, there is a strong presumption that most labor markets within the Southeast are relatively local in character with little transfer of information or workers among areas.[15] The impact of local expan-

[11] See Charles E. Bishop, "Economic Development and Adjustments of Southern Low-Income Agriculture," *Journal of Farm Economics* (forthcoming, December 1954). Also, Vernon W. Ruttan, "Comparative Data on Farm Income and Employment, 1929-51," Report #1 of the Project on Research in Agricultural Development in the Tennessee Valley Region, TVA, May 1953.

[12] Donald J. Bogue, *Population Growth in Standard Metropolitan Areas, 1900-1950,* Washington: Housing and Home Finance Agency, 1953, p. 26.

[13] Stefan H. Robock, "Industrialization and Economic Progress in the Southeast," *Southern Economic Journal,* XX (April 1954), p. 322.

[14] See C. E. Bishop and J. G. Sutherland, *op. cit.,* for documentation of this point.

[15] One factor contributing to this localization is the apparent failure of State Employment Service officials to develop staff cooperation in effecting interoffice employment clearance. Another factor is the lesser extent of unionization in the Southeast than in most other areas of the nation. See, for example, George R. Koons, "Regional Characteristics of Industrial Relations in Southern Industry," (an address to the Southern Economic Association, Atlanta, Georgia, November 14, 1953). Even outside of the Southeast it seems likely that the labor market is probably more "local" in character than most other major markets. See for example, Lloyd G. Reynolds, *The Structure of Labor Markets,* New York: Harper & Brothers, 1951, pp. 41-2, 77-86,

sion of nonfarm employment could, therefore, be expected to exert an especially heavy "pull" on underemployed farm workers in the local area while the impact of changes affecting the other three markets would be spread more widely throughout the region. This is not to argue that the functioning of the other three markets, especially the capital market, may not also be related to the level of local urban-industrial development. I would argue however that localization of labor markets in the Southeast is especially important in the absence of a rate of growth in nonfarm employment sufficiently large to absorb the growth in the region's labor force.

An attempt has been made to test the labor market hypothesis stated above by examining the relationship among the following seven variables for the Tennessee Valley region (table 4).

X_1–The median income of rural farm families and unrelated individuals in 1949. The median income includes the income from both farm and nonfarm sources (but not from home consumption) and can be regarded as a crude indicator of rural welfare.

X_2–Average income per full-time farm worker from farming in 1949. This can be regarded as an index of the relative level of labor productivity in agriculture. The assumption is made that the effect of variations in capital and current inputs per worker on the median income of farm families can be summarized in a single figure representing the average income per farm worker.

X_3–Percent of farm population employed in agriculture in 1950. This represents an index of the relative importance of agricultural employment.

X_4–Average income per production worker in manufacturing in 1947. This can be regarded as an index of the relative level of labor productivity in nonfarm employment.

X_5–Percent of farm population employed in nonfarm work in 1949. This represents an index of the relative importance of nonfarm employment to the rural farm population. X_3 and X_5 together account for the proportion of the total farm population that is employed.

X_6–Percent of the total population that was nonfarm in 1950. The figure is employed as an index of relative urbanization.

X_7–White farm operators as a percent of the total in 1949. This is used to reflect the economic impact of racial discrimination in education and employment in rural areas.

Two of these variables—average income per farm worker from farming (X_2) and percent of farm population employed in nonfarm work (X_5), were associated with a major share ($R^2_{1.25} = .74$; $R_{1.25} = .86$) of the variation in the median income of farm families in the Tennessee Valley region in 1949. Of these two variables, the percent of the farm population

241-48, and Clark Kerr, "The Balkanization of Labor Markets," *Labor Mobility and Economic Opportunity*, Cambridge: Technology Press, 1954, pp. 92-110. Kerr's discussion is limited by his excessive concentration on the role of craft unions.

TABLE 4. AN ANALYSIS OF FACTORS INFLUENCING THE MEDIAN INCOMES OF FARM FAMILIES IN THE TENNESSEE VALLEY REGION: 1949

(Part 1)

	Arithmetic Mean $\overline{X}_i$	Standard Deviation of the Mean σ_i	Coefficient of Simple (total) Correlation r_{1i}	Equation (1)—Seven Variables: Partial (Net) Regression Coefficient b_i	Equation (1): "Beta" Coefficient β_i	Equation (1): Coefficient of Separate (direct) Determination $\beta_i r_{1i}$	Equation (2)—Six Variables*: Partial (Net) Regression Coefficient b_i	Equation (2): "Beta" Coefficient β_i	Equation (2): Coefficient of Separate (direct) Determination $\beta_i r_{1i}$
X_1	1028.76	284.39	1.0	—	—	—	—	—	—
X_2	1039.30	319.37	.511	.360	.404	.206	.360	.405	.207
X_3	21.53	4.92	−.536	11.738	.202	−.108	11.185	.193	−.104
X_4	1386.62	416.85	.497	.011	.016	.008	—	—	—
X_5	9.60	4.35	.726	45.494	.695	.505	44.938	.687	.499
X_6	47.22	17.87	.683	2.356	.148	.101	2.537	.159	.109
X_7	89.71	16.82	.460	2.194	.131	.060	2.194	.130	.060
						R^2 = .772			R^2 = .771
						$\overline{R}^2$ = .764			$\overline{R}^2$ = .765
						$\overline{R}$ = .874			$\overline{R}$ = .875
						σ_R = .016			σ_R = .016
						$\overline{S}$ = $145.87			$\overline{S}$ = $138.25

(Part 2) *Coefficients of Simple (total) Correlation—Seven Variables*

	r_1	r_2	r_3	r_4	r_5	r_6	r_7
r_1	1.0	.511	−.536	.497	.726	.683	.460
r_2		1.0	−.020	.238	.069	.293	.123
r_3			1.0	−.401	−.842	−.570	−.402
r_4				1.0	.504	.697	.098
r_5					1.0	.709	.471
r_6						1.0	.218
r_7							1.0

(Part 3) *The Regression Equations*

(1) $X_1 = -358.77 + .36X_2 + 11.74X_3 + .01X_4 + 45.55X_5 + 2.36X_6 + 2.19X_7$

(2)* $X_1 = -334.84 + .36X_2 + 11.19X_3 + 44.94X_5 + 2.54X_6 + 2.19X_7$

* An analysis of variance indicates that each of the variables except X_4 adds significantly (at the .05 level) to the coefficient of multiple determination (R^2). However, $R^2_{1.52} = .740$; $R^2_{1.527} = .747$; $R^2_{1.5276} = .760$; and $R^2_{1.52763} = .771$. (The order of subscripts indicates the order in which each variable was added.) Also, $X_1 = 163.86 + .41X_2 + 45.46X_5$ with $\sigma_R = .018$ and $\overline{S} = 145.87$.

Source: X_1—Median income of rural farm families and individuals in 1949, estimated from data presented in U. S. Bureau of the Census, *U. S. Census of Population: 1950*, vol. II, *Characteristics of the Population*, part 42, chapter B., U. S. Government Printing Office, Washington, D. C., 1952.

X_2—Average income per farm worker from farming in 1949, estimated by TVA, see V. W. Ruttan, "Differentials in Farm Income and Employment in the Tennessee Valley Region Counties," Report #2 of the Project on Research in Agricultural Development in the Tennessee Valley Region, TVA, July 1953, for data and estimation procedures.

X_3—Percent of farm population employed in agriculture in 1950, *U. S. Census of Population: 1950, op cit.*

X_4—Average income per production worker in manufacturing in 1947, U. S. Bureau of the Census, *U. S. Census of Manufactures, 1947*, vol. II, *Statistics by States*, U. S. Government Printing Office, Washington, D. C., 1950.

X_5—Percent of farm population employed in nonfarm work in 1949, U. S. Bureau of the Census, *U. S. Census of Population: 1950, op. cit.*

X_6—Percent of the total population nonfarm in 1950, U. S. Bureau of the Census, *U. S. Census of Population, 1950, op. cit.*

X_7—White farm operators as a percent of the total in 1949, U. S. Bureau of the Census, *U. S. Census of Agriculture: 1950*, vol. I, *Counties and State Economic Areas*, U. S. Government Printing Office, Washington, D. C., 1952.

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employed in nonfarm work (X_5) is of considerably greater importance than the level of labor productivity within agriculture (X_2) ($B_5 = .687$; $B_2 = .405$).

Three other variables—the percent of the population employed in agriculture (X_3), the percent of the total population that was nonfarm (X_6), and white farm operators as a percent of the total (X_7)—are associated with a relatively small but statistically significant share of the variation in the median income of rural farm families. Variations in the level of nonfarm income, as reflected by the income of production workers in manufacturing (X_4), either exert no significant influence on the median income of farm families or its influence is obscured by its high intercorrelation with the percent of the farm population employed in nonfarm work and the percent of the total population nonfarm ($r_{45} = .504$; $r_{46} = .697$).

How are these results to be interpreted? *First,* it is clear that the major impact of urban-industrial development on the median incomes of farm families is exerted directly through the participation of members of farm families in nonfarm employment. The direct impact of job availability appears to be far more important than either (a) the direct impact of the level of earnings in nonfarm employment, or (b) the other influences of urbanization measured by the percent of the total population nonfarm. This is clearly consistent with our hypothesis (p. 5) that *the major income effects of local urban-industrial development are transmitted to the agricultural sectors of the local economy through the labor market.*

Second, the racial composition of the farm population appears to be relatively unimportant in explaining variations in the median incomes of farm families. This result should not have been entirely unexpected, in view of the results of Professor Fulmer's analysis of 1940 data.[16] However, while racial characteristics are relatively unimportant, they do exert a statistically significant influence. Furthermore, there is a strong presumption that the nonwhite farm operators are concentrated most heavily in areas furthest from urban centers ($r_{67} = .218$) with the result that the "*true*" relationship may be slightly underestimated as a result of this bias.[17] Even so, the data are consistent with the following proposition: *For any given level of urbanization, a high percentage of non-white farm operators is generally associated with a higher proportion of the farm population engaged in agriculture ($r_{37} = .402$) and a lower proportion engaged in nonfarm employment ($r_{57} = .471$) than would be the case if non-white farm operators represented a relatively low percentage of the total farm population.*

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[16] Fulmer, *op. cit.,* p. 263.

[17] This is consistent with data indicating considerable differentials in average and median incomes between white and non-white farm operators. See for example, Lewis Jones and Ernest Neal, "Negro Farmers in the Tennessee Valley," Tuskegee Institute, Rural Life Council, Tuskegee, Alabama, 1954 (mimeographed).

Third, the impact of urban-industrial development on labor productivity in agriculture—on the average income per farm worker from farming—is much less pronounced than its influence on the median incomes of farm families (r_{15} = .726; r_{16} = .683; r_{25} = .293, see Tables 5 and 6). Furthermore, the direct impact of urbanization, as measured by the percent of the farm population employed in nonfarm work (X_5), appears to exert a negative influence on average income per farm worker from farming; while the other influences of urbanization, as measured by the percent of the population nonfarm (X_6), appear to exert a positive influence on the average income per farm worker (see table 5).[18] It is clear, however, that the net effect of the two indicators of urban-industrial development is positive (B_5 = —.337; B_6 = .469) even though they together account for only about 12.5 percent of the variation in average income per farm worker ($R^2_{1.56}$ = .125). While these results are consistent with the urban impact hypothesis the size of the impact of local urban-industrial development on labor productivity in agriculture is disappointingly small. Either the impact is small or it is so broadly diffused that its full impact on labor productivity does not show up in the form of county differentials.

One's first reaction to the existence of a negative relationship between average income per farm worker from farming and the percent of the farm population employed in nonfarm work is one of doubt. High intercorrelation between the percent of the farm population working off the farm and the percent of the total population nonfarm (r_{56} = .709) may tend to reinforce this doubt. A rationale for acceptance of the observed relationship can be developed, however. Information on the employment practices of plants using rural workers indicates that nonfarm employment of members of farm families is selective toward the younger and median age groups.[19] As a result, it is reasonable to suspect that an increase in the proportion of the farm population employed in nonfarm work (i.e., a decline in the proportion employed in agriculture) could result in a decline in the productivity, and hence the average income per worker from farming of those workers remaining in agriculture.

In the next section an attempt will be made to determine the extent

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[18] Using 1940 data on gross farm income per farm and average annual wages per worker in manufacturing, Gale Johnson concluded: "There does not seem to be any relation, either in the South or the North Central States between the level of nonfarm income and farm income, if countries are used as a basis of comparison," ("Functioning of the Labor Market," *Journal of Farm Economics,* XXXIII, February 1951, p. 81). Our results are apparently consistent with Johnson's. Although r_{24} = .238, average income per production worker in manufacturing (X_4) does not add significantly to coefficient of multiple determination (R^2).

[19] B. M. Wofford and T. A. Kelly, "The Sources and Efficiency of Working Forces in Selected Mississippi Industrial Plants," (mimeographed), Mississippi State College Business Research Station; N. A. Beadles, "Some Myths About the Character of the Southern Labor Force," (paper presented to the annual meeting of the Southern Economic Association, Biloxi, Mississippi, November 19-20, 1954).

TABLE 5. AN ANALYSIS OF SELECTED FACTORS INFLUENCING THE AVERAGE INCOME PER FARM WORKER FROM FARMING IN THE TENNESSEE VALLEY REGION: 1949

(Part 1)

	Arithmetic Mean $\bar{X}_i$	Standard Deviation of the Mean σ_i	Coefficient of Simple (total) Correlation r_{2i}	Equation (3)—Six Variables: Partial (Net) Regression Coefficient b_i	Equation (3)—Six Variables: "Beta" Coefficient β_i	Equation (3)—Six Variables: Coefficient of Separate (direct) Determination $\beta_i r_{2i}$	Equation (4)—Four Variables*: Partial (net) Regression Coefficient b_i	Equation (4)—Four Variables*: "Beta" Coefficient β_i	Equation (4)—Four Variables*: Coefficient of Separate (direct) Determination $\beta_i r_{2i}$
X_2	1039.30	319.37	1.000	—	—	—			
X_3	21.53	4.92	−.020	5.433	.084	−.002			
X_4	1386.62	416.85	.238	.072	.094	.022			
X_5	9.60	4.35	.069	−24.751	−.337	−.023	−29.676	−.404	−.028
X_6	47.22	17.87	.293	8.390	.469	.138	9.588	.537	.157
X_7	89.71	16.82	.123	3.868	.204	.025	3.727	.196	.024
						R^2 = .160			R^2 = .153
						$\bar{R}^2$ = .138			$\bar{R}^2$ = .140
						$\bar{R}$ = .373			$\bar{R}$ = .374
						σR = .060			σR = .060
						$\bar{S}$ = \$297.14			$\bar{S}$ = \$306.56

(Part 2) *The Regression Equations*

(3) $X_2 = 316.77 + 5.43X_3 + .07X_4 - 24.75X_5 + 8.39X_6 + 3.87X_7$

(4) $X_2 = 537.09 - 29.68X_5 + 9.59X_6 + 3.73X_7$

NOTE: See table 4 for intercorrelation coefficients and description of variables.

* An analysis of variance indicates that (at the .05 level) the addition of X_3 and X_4 does not significantly increase the coefficient of multiple determination (R^2). However, $R^2_{2.56}$ = .125; $R^2_{2.567}$ = .153; $R^2_{2.4567}$ = .159 and $R^2_{2.34567}$ = .160. The variables were added in order of their relative importance as indicated by the "beta" coefficients computed from equation (3).

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to which this residual impact that does result from urban-industrial development is exerted through the capital market, as compared to the impact which is exerted through the markets for farm products and current inputs.

III. *Functioning of the Capital Market Also Closely Related to Urban-Industrial Development*

Along with the labor market, the capital market is regarded by many students as functioning rather inefficiently in allocating resources among farm firms and even more inefficiently in allocating resources among rural areas and between farm and nonfarm uses.[20] Schultz has argued that the efficiency with which the capital market allocates capital among farm firms is closely related to the level of local urban-industrial development.[21]

If this hypothesis is correct, we would expect to find in any area that: (a) *average income per farm worker is positively related to the level of capital inputs per worker;* (b) *the level of capital inputs per farm worker is positively related to the level of urbanization in the same general area;* and (c) *to the extent the functioning of the product markets and the market for current inputs is associated with urbanization, the percent of the total population nonfarm would also be positively related to the average income per farm worker.*

In an attempt to test this hypothesis, the relationships between the following six variables have been examined:

X_1–Average income per farm worker from farming in 1949.
X_2–Average acres of cropland per farm worker in 1950, and
X_3–Average value of land and buildings per farm worker in 1950. X_2 and X_3 act as indicators of the level of land and long-term capital inputs.
X_4–The average number of tractors per 100 farm worker in 1950. This is used as a crude indicator of the level of mechanization.
X_5–Average value of livestock per farm worker in 1950. X_4 and X_5 together are assumed to measure level of intermediate capital inputs.
X_6–Percent of the total population nonfarm in 1950. This figure is employed as an index of relative urbanization.

An examination of the patterns of agricultural output in the Valley region seemed to indicate that the counties of the region could be divided into at least two major areas depending on the relative importance of cotton and tobacco in each county. There were only six counties in the entire region in which cotton and tobacco each accounted for more than

[20] T. W. Schultz, "Factor Markets and Economic Development," *The Economic Organization of Agriculture, op. cit.*, pp. 283-312; Walter W. Wilcox, "Effects of Farm Price Changes on Efficiency in Farming," *Journal of Farm Economics*, XXXIII (February 1951), pp. 55-65; C. E. Bishop, "Underemployment of Labor in Southeastern Farms," *Journal of Farm Economics*, XXXVI (May 1954), pp. 264-68.

[21] Schultz, *op. cit.*, pp. 366-67.

5 percent of total sales of farm products.[22] Analysis of the differences between means of the several variables for 88 cotton and 107 tobacco-livestock counties indicated significant differences (at the 5 percent level) between the level of investment in land and buildings per farm worker (X_3), number of tractors per 100 farm workers (X_4), and value of livestock per farm worker (X_5). No statistically significant differences were observed in average income per farm worker (X_1), average acres of cropland per worker (X_2), or the percent of the total population nonfarm (X_6). A decision to analyze the relationships between the six variables separately in each area was made on the basis of the significant difference obtained for the three capital input items.

In the *cotton counties* (table 6) the only statistically significant variable is the number of tractors per 100 farm workers (X_4). The coefficient of correlation (r) between average income per farm worker from farming and number of tractors per 100 farm workers is .687. Variations in the average value of land and buildings per farm worker (X_3), the average acres of cropland per farm worker (X_2) and the average value of livestock per farm worker (X_5) do not exert a statistically significant influence on average income per farm worker nor do variations in the percent of the total population nonfarm (X_6).

In the *tobacco-livestock* (table 7) counties there are two statistically significant variables. They are the average value of livestock per farm worker (X_5) and the percent of the total population nonfarm (X_6). Of these two variables, the average value of livestock per farm worker is the more important factor. Neither the average acres of cropland per farm worker (X_2), the average value of land and buildings (X_3), nor the number of tractors per 100 farm workers (X_4) contributed significantly (at the 5 percent level) to the average income per farm worker.

Before going on to present an interpretation of these results, a word of caution should be noted. The regression equations which express the relationship between average income per farm worker from farming and the several capital input items for the cotton and tobacco-livestock counties should not be regarded as agricultural production functions. These equations are quite different than the functions used in farm management analysis: (a) they are based on county averages rather than on data for individual farms; (b) even though the cotton and tobacco-livestock areas have been treated separately the data for each area are drawn from counties with rather large differences in farming systems; and (c) both production theory and the results of empirical investigations would lead us to suspect that relationships between factor inputs and outputs are

[22] Re-examination of the county production patterns indicates that it might have been desirable to divide the Valley region into three groups: (a) cotton, (b) tobacco-livestock, and (c) subsistence farming areas.

TABLE 6. AN ANALYSIS OF THE RELATIONSHIP BETWEEN AVERAGE INCOME PER FARM WORKER FROM FARMING AND CAPITAL INPUTS IN 88 TENNESSEE VALLEY REGION COTTON COUNTIES

(Part 1)

	Arithmetic Mean	Standard Deviation of the Mean	Coefficient of Simple (total) Correlation	Equation (1)—Six Variables: Partial (Net) Regression Coefficient	Equation (1)—Six Variables: "Beta" Coefficient	Equation (1)—Six Variables: Coefficient of Separate (Direct) Determination	Equation (2)—Two Variables: Partial (Net) Regression Coefficient	Equation (2)—Two Variables	Equation (2)—Two Variables: Coefficient of Determination
	$\overline{X}_i$	σ_i	r_{1i}	b_i	β_i	$\beta_i r_{1i}$	b_i		$r_{1i.}$
X_1	1040.11	323.02	1.0	—	—	—	—	—	—
X_2	32.00	8.53	.471	11.06	.292	.138	—	—	—
X_3	4113.30	2631.41	.391	.02	.167	.065	—	—	—
X_4	20.44	8.68	.687	18.70	.503	.346	25.59	—	.472
X_5	562.50	246.69	−.002	−.40	−.346	.001	—	—	—
X_6	45.74	17.57	.247	−1.56	−.085	−.021	—	—	—

Equation (1): $R^2 = .529$; $\overline{R}^2 = .501$; $\overline{R} = .708$; $\sigma_R = .052$; $\overline{S} = \$220.00$

Equation (2): $r^2 = .472$; $\overline{r}^2 = .466$; $r = .683$; $\sigma_r = .057$; $\overline{S} = \$237.40$

(Part 2) *Coefficients of Simple (total) Correlation—Six Variables*

	r_1	r_2	r_3	r_4	r_5	r_6
r_1	1.0	.471	.301	.687	−.002	.247
r_2		1.0	.324	.688	.623	.352
r_3			1.0	.488	.263	.427
r_4				1.0	.194	.450
r_5					1.0	.223
r_6						1.0

(Part 3) *The Regression Equations*

(1) $X_1 = 516.03 + 11.06X_2 + .02X_3 + 18.70X_4 - .40X_5 - .15X_6$

(2) $X_1 = 517.05 + 25.59X_4$

Source: X_1—Average income per farm worker from farming in 1949, estimated by TVA. See Vernon W. Ruttan, "Differentials in Farm Income and Employment in the Tennessee Valley Region Counties," Report #2 of the Project on Research in Agricultural Development in the Tennessee Valley Region, TVA, July 1953, for data and estimation procedures.

X_2—Average acres of cropland per farm worker in 1950, U. S. Bureau of the Census, *U. S. Census of Agriculture: 1950*, vol. I, *Counties and State Economic Areas*, U. S. Government Printing Office, Washington, D. C., 1952 for county totals; *Ibid.*, for estimates of the number of farm workers.

X_3—Average value of land and buildings per farm worker in 1950; *Ibid.*

X_4—Number of tractors per 100 farm workers in 1950, *Ibid.*

X_5—Value of livestock per farm worker in 1950, *Ibid.*

X_6—Percent of the total population nonfarm in 1950, U. S. Bureau of the Census, *U. S. Census of Population, 1950.*

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TABLE 7. AN ANALYSIS OF THE RELATIONSHIP BETWEEN AVERAGE INCOME PER FARM WORKER FROM FARMING AND CAPITAL INPUTS IN 107 TENNESSEE VALLEY REGION TOBACCO AND LIVESTOCK COUNTIES

(Part 1)

	Arithmetic Mean	Standard Deviation of the Mean	Coefficient of Simple (Total) Correlation	Equation (1)—Six Variables			Equation (2)—Three Variables		
				Partial (Net) Regression Coefficient	"Beta" Coefficient	Coefficient of Separate (Direct) Determination	Partial (Net) Regression Coefficient	"Beta" Coefficient	Coefficient of Separate (Direct) Determination
	$\overline{X}_i$	σ_i	r_{1i}	b_i	β_i	$\beta_i r_{1i}$	b_i	β_i	$\beta_i r_{1i}$
X_1	1041.18	320.10	—	—	—	—	—	—	—
X_2	32.92	13.63	.340	3.21	.137	.047	—	—	—
X_3	5202.99	2165.03	.325	.005	.035	.011	—	—	—
X_4	15.54	10.03	.341	1.14	.036	.012	—	—	—
X_5	832.06	359.67	.469	.27	.308	.144	.35	.397	.186
X_6	48.65	18.18	.377	4.41	.250	.094	4.78	.271	.102
						R^2 = .308			R^2 = .288
						$\overline{R}^2$ = .273			$\overline{R}^2$ = .274
						$\overline{R}$ = .523			$\overline{R}$ = .524
						σR = .069			σR = .070
						$\overline{S}$ = \$274.80			$\overline{S}$ = \$274.05

(Part 2) *Coefficients of Simple (total) Correlation—Six Variables*

	r_1	r_2	r_3	r_4	r_5	r_6
r_1	1.0	.340	.325	.341	.469	.377
r_2		1.0	.019	.790	.487	.099
r_3			1.0	.443	.443	.572
r_4				1.0	.357	.309
r_5					1.0	.266
r_6						1.0

(Part 3) *The Regression Equations*

(1) $X_1 = 448.89 + 3.21X_2 + .005X_3 + 1.13X_4 + .27X_5 + 4.41X_6$

(2) $X_1 = 515.36 + .35X_5 + 4.78X_6$

Source: See table 6 for sources and definition of terms.
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curvilinear rather than linear. In this study only linear relationships have been employed. The analysis does permit a test of the hypothesis listed above in spite of its deficiencies from the point of view of production theory.[23]

The hypothesis that average income per farm worker is positively related to the level of capital inputs per worker is consistent with the data for at least one capital input item in both areas. Nevertheless, some of the results of the analysis are rather surprising.

a. In spite of the small number of acres of cropland per farm worker (about 32 acres in each area) and the small investment in land and buildings per farm worker—averaging $4,133 in the cotton counties and $5,203 in the tobacco counties—the analysis does not reveal a significant relationship between either of these two indexes of long-term capital inputs and average income per farm worker in either the cotton or the tobacco counties. A number of other studies, including the studies by Hughes in east Tennessee,[24] Johnson in western Kentucky,[25] and Heady and Shaw in north Alabama,[26] have indicated a low marginal productivity of investment in land and buildings in parts of the same area covered by this study. It has been suggested that a combination of the relatively low level of managerial ability of farm operators and extremely low level of capital and land inputs is responsible for a statistical conclusion that may not have too much meaning for the future.[27]

b. In the cotton counties, the only statistically significant variable is the number of tractors per 100 farm workers. This result would certainly not lend support to proponents of grassland-livestock agriculture in the cotton counties. Livestock apparently did not repre-

[23] The analysis should also be useful in identifying areas for special analytical purposes. It would be very interesting, for example, to analyze the factors which permit certain counties to achieve exceptionally high levels of income per farm worker for given levels of capital inputs and extent of urbanization. An examination of tne several dot diagrams indicates, for example, that the four northern delta counties (Fulton, Kentucky, and Dyer, Obion and Lake, Tennessee) each has achieved substantially higher incomes per farm worker than could be expected on the basis of X_2, average acres of cropland per farm worker; X_3, average value of land and buildings per worker; and X_5, average value of livestock per farm worker. This is true in spite of the fact that these counties do not depart significantly from the relationship between the median income of farm families and the percent of the total population nonfarm.

[24] R. B. Hughes, "Marginal Returns on Agricultural Resources in a Southern Mountain Valley," *Journal of Farm Economics,* XXXVI (May 1954), pp. 334-39.

[25] Glenn L. Johnson, *Sources of Income on Upland Marshall County Farms,* progress Report 1, Kentucky Agricultural Experiment Station, University of Kentucky, Lexington (see also the reports for other western Kentucky counties).

[26] Earl O. Heady and Russell Shaw, "Resource Returns and Productivity Coefficients in Selected Farming Areas," *Journal of Farm Economics,* XXXVI (May 1954), pp. 243-57.

[27] Heady and Shaw, *Ibid.,* p. 253.

sent a profitable enterprise on most farms even during 1949, a period of relatively high livestock prices.

c. In the tobacco-livestock counties, the number of tractors per 100 farm workers did not exert any statistically significant influence on average income per farm worker. However, this result does not appear unreasonable in view of the high value output per acre in tobacco production and the small size of tobacco allotments.

The hypothesis that the level of capital inputs per farm worker is positively related to the level of urbanization in the same general area is consistent with the data for both areas. All of the coefficients of simple (total) correlation between capital input items ($X_2 \ldots X_5$) and the index of urbanization (X_6) are positive. This result tends to substantiate Schultz's hypothesis that the capital market functions more efficiently in area near developing urban-industrial complexes.

IV. *Functioning of the Product and Current Input Markets Less Closely Related to Urban-Industrial Development*

The hypothesis that urbanization exerts an independent impact on income per farm worker, over and above the impact exerted through the capital market, is consistent with the data for the tobacco-livestock counties but is not consistent with the data for the cotton counties. In the cotton counties, the percent of the total population that is nonfarm does not exert a statistically significant influence on average income per farm worker.

It seems likely that the positive association between average income per worker and the percent of the total population that is nonfarm in the tobacco-livestock counties reflects the more efficient functioning of the markets for products and current inputs in areas near urban centers. The tobacco-livestock counties are heavily concentrated in the upland areas of the Valley region where, until fairly recently, travel and communication have been fairly difficult. In these circumstances, it seems reasonable to believe that the efficiency of the product and current input markets would be related to the level of local urban-industrial development.[28] Even in the tobacco-livestock counties the analysis would seem to indicate that the impact on income per farm worker exerted through the product and current input markets is less important than the influence exerted through the capital market alone. This conclusion is especially

[28] For a discussion of some of the product market effects, see John L. Fulmer, "Urbanization and Agriculture," in *Agricultural Progress in the Cotton Belt Since 1920*, North Carolina: Chapel Hill, 1950, pp. 123-29, and W. E. Christian, "Impact of Industrialization upon the Marketing Outlets for Locally Produced Farm Products," (Paper presented at the annual meeting of the Southern Economic Association, Biloxi, Mississippi, November 19-20, 1954).

interesting in view of the relatively large agricultural research funds being devoted to improving the product and current input markets and the relatively small funds being devoted to improving the capital and labor markets.

V. *Summary and Conclusions*

The results of this study can be summarized in five steps.

First, the level of income achieved by *nonfarm* families and individuals in any given area is closely related to the level of urban-industrial development in the same general area.

Second, the median income level achieved by *farm* families in the areas studied was almost as closely related to the level of local urban-industrial development as was the median income of *nonfarm* families in 1949.

Third, in the Tennessee Valley region the labor market appears to be the major channel through which the impact of local urban-industrial development is transmitted to farm families. Increased off-farm jobs by members of farm families were more important in raising the income level of farm families than even increased labor productivity in agriculture.

Fourth, the direct impact on labor productivity in agriculture (on income per farm worker from farming) of increased nonfarm employment by members of farm families appears to be negative. This negative influence is, however, more than offset by the positive influences of local urban-industrial development which is exerted through the markets for capital, current inputs, and farm products.

Fifth, in the 88 cotton counties of the Tennessee Valley region, the impact of local urban-industrial development which is not exerted directly through the labor market seems to be exerted almost entirely through the capital market. In the 107 tobacco-livestock counties, there appears to be a residual impact exerted through the markets for farm products and current inputs as well as through the labor and capital markets.

RESOURCE USE AND PRODUCTIVITY IN WORLD AGRICULTURE*

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THE primary purpose of this paper is to make a study of the productivity of resources used in agricultural production in the world and to obtain some idea of the relative efficiency in their use. The method of study will be through the fitting of a single-equation production function to the data of agricultural inputs and output for selected countries of the world. The selection of these countries has been determined entirely by the availability of the needed statistics.

One of the major assumptions underlying the present study is that the input-output relationship in the agricultural production of the world can be expressed through a single production function. There are many sound theoretical objections to a sweeping assumption like this. There are problems of measurement of the variables in comparable units, of heterogeneity in the composition of the same variable in different countries and, above all, the complex problems of aggregation involved in an international production function. These problems are too serious to be lightly brushed aside. The best plea that can be made is that if such a function can be fitted to the existing data, it will have to be interpreted with extreme caution and reservation, and in a way different from the interpretation attached to agricultural production functions derived from national or regional data. The analogy, that if a production function can be conceived for the agriculture of a single country in spite of the diversity of farms and farming techniques within it, a similar function can also be justified for the agriculture of the world wherein the different countries are like the farms within a nation, is no doubt carried very far, but sounds, in any case, somewhat logical too.

Choice of a Function

As pointed out earlier, a single equation will be used to explain the generation of agricultural output in a group of countries of the world from various resource inputs. Custom and usage have shown that among the various types of functions, the Cobb-Douglas type has several advantages. The function to be used for this study is of the same type. It

* The paper summarizes one section of the doctoral dissertation submitted by the author to the University of Illinois in August, 1953. The author is indebted to Prof. L. J. Norton, Prof. E. J. Working, and Prof. V. I. West for suggestions, comments and criticisms of value when the work was in progress.

is linear in logarithms and can be written in the following general form:

$$X_1 = A.X_2^b X_3^c \ldots X^p_n; \text{ or } \log X_1 = \log A + b.\log X_2 + c.\log X_3 + \ldots + p.\log X_n.$$

The most important advantages of this type of function are two-fold. Firstly, the coefficients of the function are equal to the elasticities of production in respect to the different inputs. In other words, b, c, . . ., p, are the elasticities of production of the input items, X_2, X_3, . . ., X_n, respectively. Secondly, the function makes it possible for the principle of diminishing returns to operate within the scale. No assumption will, however, be made at this stage about the degree of the function. In other words, no restriction is being applied now to the sum of the coefficients of the independent variables. Thus $b + c + d + \ldots + p$ may or may not be equal to 1.

Nature of the Variables

The variable, X_1, in the above equation stands for agricultural output. It is obvious that X_1 will have to be a measure of output that will express the sum total of the different components of the agricultural output in each country and at the same time be expressed in an international unit of value. Unfortunately, separate figures of the value of total agricultural output are available for only a few countries of the world. The only alternative is, therefore, to obtain this measure from the national income statistics of different countries. The United Nations has published national income estimates for a large number of countries. For quite a few of these, statistics of the origin of the national income by industrial groups are also available.[1] From these statistics we can compute the contribution to the national income of each country of its agriculture sector. The magnitude that is obtained in this way is net agricultural output at factor cost (net, in the sense, produced within the country only). The variable, X_1, thus measures "net" agricultural output of each country. It is expressed in constant United States dollars by being converted at the "adjusted pre-war exchange rate,"[2] and relates to the latest post-war year for

[1] See, for example, Statistical Office of the U.N. Department of Economic Affairs, *National and Per Capita Incomes of Seventy Countries in 1948 Expressed in United States Dollars*, U.N. Statistical Papers, Series E, 1, (New York, 1950); and *National Income and Its Distribution in Under-developed Countries*, U.N. Statistical Papers, Series E, 3, (New York, 1951).

[2] The estimate of the national income of each country has been converted into U.S. dollars of 1939 at the "adjusted pre-war exchange rate—i.e., at the 1938 rate adjusted for relative changes in the cost of living between 1938 and 1949 in the U.S. and in the country in question." See U.N. Statistical Papers, E, 1, *Op. Cit.*, p. 17. This is not a satisfactory method of conversion by any means and has now been discarded even by the United Nations. But this is the only method used in the publication mentioned above. In fact, even this method could have been improved on if the index of wholesale prices had been used as the deflator, because national income is being used by us as a measure of output, not of welfare or well-being.

which an estimate of the national income is available for each country.

The variables, $X_2, X_3, \ldots, X_n$, in the production equation stand for the different items of resource input. Resources can be classified into three broad groups, human, natural and material. It is difficult to follow this classification in empirical work, because statistics are not available for such broad groups of resources. Besides, such broad grouping involves problems of aggregation that are very difficult to solve. Consequently, these broad groups of resources will be broken down into specific items of input for which statistical series are available.

The human resource can be classified in two respects, that of quantity and quality. For statistics of quantity of human resource put into production reliance has to be placed, for the purely practical reason of availability, on the number of persons employed in agricultural occupations in different countries, even though this is for obvious reasons not an accurate measure of the labor input in agriculture in different countries. This will be X_2 in the production equation. No measure of the quality of the human resource is available. Included under the quality of the human resource are all those attributes that are described as managerial and entrepreneurial ability. The existing level of this quality will, obviously, vary from one country to another and be responsible for a part of the disparity in output among the countries. But this is, unfortunately, one of those inputs that have not yet been quantified, even in the field of micro-economic analysis of farms. So there is no other alternative but to forget it.

Among the natural resources used in agriculture the most important is land. Climate and water would be the other important resources to be taken into consideration in conjunction with land. There are no measures available of the last two. But since the productive quality of land is affected by them, a measure of the land resource, if properly worked out, will have to include the other two. The most important difficulty in the measurement of land as a single category arises from the fact that there are different classes of land, like arable land, pasture, forest, and other lands, showing wide variations among them in productive capacity. This difficulty cannot be overcome unless some system of weighting of the different classes of land is evolved. The system of weighting can be based on either geographical or economic standards. It is understood that some of the prominent geographers of the world are now working on this problem, but it will be quite some time before the results of their efforts are available. The procedure followed in obtaining weights would be to take into account climate, availability of water, and other factors that affect the productive capacity of land plus the soil resources. Colin Clark has used a simplified version of this system of weighting to convert different

classes of agricultural land into "standard farm land,"[3] but Clark's figures refer to pre-war years and to broad groups of countries. For many of the underdeveloped countries the breakdown of the figures is not available.

The other system of weighting is based on the economic capacity of the different classes of land. Under this system, lands of different classes are given weights on the basis of the value of products they turn out. When such a monetary or value base is adopted, all the difficulties of inter-comparison present themselves, not only in international studies but also in inter-regional analysis. The system of weighting based on the economic capacity of different classes of land has two components, one arising out of the inherent productive capacity of land as determined by the natural (geographical) factors, and the other arising out of the price ratio of the products that different classes of land turn out. It is the latter component that causes most of the difficulties. The Food and Agriculture Organization of the United Nations is using this system to obtain figures of "weighted arable land,"[4] avoiding, however, a monetary value base for purposes of conversion. These figures are not yet available for many of the countries of the world.

We propose to follow a simple system of converting pasture lands into arable land equivalents and add them to the area of arable land to obtain a measure of the land input. The basis of conversion will be the number of livestock (cattle) that a unit area (say, an acre) of each of the two classes of land can support. This is, of course, a crude way of weighting. But it has an advantage over the system based on the value of the products, in that the number of cattle provides more comparable a base than does monetary value. For some of the countries this conversion has to be made arbitrarily, because sufficient information and data are not available. Thus we have obtained the conversion ratio of pasture to arable land, the value of which for different countries varies from .01 to .05. The areas of arable and pasture lands for different countries that we shall use will be designated by X_3 in the production equation.

Material resources present some very difficult problems in measurement. In general, by material resources are meant all those items of input

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[3] Colin Clark, *The Conditions of Economic Progress* (London: Macmillan and Co., Ltd., 1951), pp. 199-208. The method of this weighting is explained there.

[4] The weighting, in this case, had the effect of increasing the area for intensively cultivated lands and decreasing that of extensively cultivated lands. The method is explained as follows: "In order to present a fairer comparison between arable land areas in the various countries, the areas under grains and root crops were weighted by the ratio of national yields (for grains and root crops respectively) to the average yield (weighted by planted areas) of all countries. In this way an adjustment for productivity was accomplished. Other categories of arable land remain unadjusted." *F.A.O. Monthly Bulletin, Food and Agricultural Statistics*, Vol. IV, 2-3, February-March 1951, p. 4.

that can be grouped under the broad term, capital. To avoid all the theoretical and practical problems involved in trying to measure capital in terms of value, we shall use different items of physical input which come under this category. The following are the items of input for which statistics are available: number of livestock, consumption of fertilizers, and number of tractors used in agriculture. There are variables like consumption of energy on which agricultural income shows significant partial regression. But they are hardly relevant to agricultural production and have, therefore, been left out of consideration.

There is also need for some standard unit of measurement in the case of livestock numbers. At the risk of some criticism, we have used the conversion factors that the Food and Agriculture Organization of the United Nations uses for converting all kinds of livestock into a standard livestock unit, comparable among different countries. The conversion factors for the different kinds of livestock[5] are cattle 0.8, pigs 0.2, sheep and goats 0.1, and horses, mules, and buffaloes 1.0. But in many of the countries of the world livestock is also used for draft and other work purposes. The nature of the contribution of livestock to agricultural production will not be clearly brought out unless the work-stock (livestock used for work) is separated from what the F.A.O. calls "productive" livestock. Cattle, pigs, sheep, and goats are classified by the F.A.O. as productive animals, while horses, mules and buffalo are called draft animals. We shall follow this classification of livestock. Consequently, there will be two variables to take account of the contribution of livestock to agricultural production—X_5 for number in standard animal units of "productive" livestock and X_6 for that of work stock.

It is easy to find statistics of total consumption of fertilizers for each country. Under fertilizers we are including chemical fertilizers only, leaving out the consumption of manure and other natural fertilizers. This will be X_4 in the production equation. Number of tractors in use in agriculture in each country is a very approximate measure of the non-animal power used in agriculture in different countries. The total horsepower of such tractors would have been, in many ways, a better measure of the amount of mechanical power used in agriculture in different countries. But, unfortunately, statistics of horsepower of tractors are not available. So we shall have to be satisfied with their number as a rough measure of the input of machinery and equipment. This will be X_7 in the equation. These are all the items of input of material resources for which data are available. They will all be included in the analysis. It is obvious that

[5] *F.A.O. Yearbook of Food and Agricultural Statistics*, 1951 (Rome: Food and Agriculture Organization of the United Nations, 1952), V. 1.

a few important items of input like farmstead and buildings are being left out because of the lack of relevant data.

Statistics in respect to the seven variables mentioned above are given for twenty-two countries in Table 1, along with the figures of the ratio

TABLE 1. STATISTICS OF NET AGRICULTURAL INCOME, AGRICULTURAL POPULATION LAND, AND OTHER RESOURCE INPUTS IN DIFFERENT COUNTRIES

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
United States	17,346	8,851	468,033	.02	77,474	825	3,952.1	3,550,000
Canada	1,935	1,272	91,266	.02	7,655	1,796	192.1	367,828
United Kingdom	2,102	1,221	18,960	.02	9,604	625	765.9	308,450
Norway	290	495	2,018	.02	1,251	198	99.6	9,506
France	3,137	7,490	52,796	.02	26,070	2,613	870.8	122,624
Western Germany	1,790	4,247	21,399	.02	10,202	1,628	1,283.6	109,776
Argentina	1,373	1,570	79,789	.02	32,294	772	13.9	25,000
Denmark	614	540	6,656	.02	2,903	532	196.8	12,257
Netherlands	610	746	2,760	.02	2,122	276	368.5	15,950
Union of S. Africa	438	2,651	25,071	.05	13,690	158	90.0	39,500
Eire	388	594	3,877	.02	3,661	526	60.0	9,480
Poland	2,769	7,035	41,755	.02	6,467	2,541	158.4	14,500
Chile	185	732	14,688	.02	2,699	613	35.4	6,000
Puerto Rico	160	246	1,023	.05	336	60	65.4	2,150
Japan	2,346	18,623	14,852	.02	1,094	1,989	628.6	1,810
Italy	3,348	9,127	38,337	.02	8,700	1,932	346.3	50,590
Mexico	604	3,803	29,640	.02	12,906	6,583	13.8	32,000
Greece	411	1,507	8,255	.02	1,645	793	38.1	2,869
Turkey	1,199	5,724	37,552	.01	12,664	3,915	6.3	3,959
Egypt	885	7,558	6,039	.01	4,416	2,406	97.5	5,400
Peru	286	1,777	4,718	.02	4,440	1,141	47.7	2,400
India	9,297	90,523	336,266	.05	83,328	75,373	64.3	7,500

(1) Country
(2) Net agricultural Output, Million \$, X_1
(3) Population Active in Agriculture (000), X_2
(4) Arable Land Equivalent (000 acres), X_3
(5) Conversion Ratio of Pasture of Arable Land
(6) Productive Livestock (000 animals units), X_5
(7) Work Stock (000 units), X_6
(8) Fertilizer Consumption (000 metric tons), X_4
(9) Number of Tractors in Agriculture, X_7
Source: Computed and compiled from: *National and Per Capita Incomes of Seventy Countries in 1949 Expressed in U. S. Dollars*, U. N. Statistical Papers, Series E, 1 (New York; 1950); *National Income and Its Distribution in Under-developed Countries*, U. N. Statistical Papers, Series E, 3 (New York; 1951); and *F.A.O. Yearbook of Food and Agricultural Statistics, 1951* (Rome; 1952), Vol. i.

of conversion of pasture lands to arable lands. The values of the resource inputs for each country are, as far as possible, for the year to which the figure of net agricultural output relates.

Regression Equations

Multiple regressions of X_1, on different combinations of the resource inputs have been worked out in logarithms of the value of the variables.

The values of the coefficients of net regression, the coefficient of multiple regression, the standard error of estimate and of the standard errors of the regression coefficients are given in Table 2. Different combinations of the resource inputs are denoted by I, II, III, IV and V. In combination I, the regression of X_1 on X_2 and X_3 only has been taken into account; in combination II the regression of X_1 on X_2, X_3 and X_4 only has been considered; and so on, as will be evident from Table 2. It should be mentioned here that the variables, X_5 and X_6—namely, those relating to livestock—have not given any reliable and significant coefficients of net regression. It is for this reason that all the possible combinations have not been included in Table 2. Only those that have yielded interesting and significant results are given in the Table.

TABLE 2. VALUES OF THE COEFFICIENTS IN THE PRODUCTION EQUATION AND MEASURES OF THE RELIABILITY OF THE EQUATION

Independent Variables	Symbol of Coefficient	Values of Coefficients in Different Production Equations with X_1 as Dependent Variable				
		I	II	III	IV	V
Population in Agriculture, X_2	b	0.312994	0.276509	0.276972	0.301043	0.450308
Land (Weighted Arable), X_3	c	0.460011	0.425308	0.389561	0.363925	0.494073
Fertilizer Consumption, X_4	d		0.286604	0.288817	0.270153	
Productive Livestock, X_5	e			0.044796	0.037176	−0.016222
Livestock for Work, X_6	f					−0.179475
Tractors in Use, X_7	g				0.027062	
Sum of the Coefficients		0.77305	0.988421	1.000146	0.999359	0.748684
Constant term (in log)	A	3.676342	2.697986	2.638623	2.701119	3.742901
Constant term (in real units)	A	4746.154	498.868	435.134	502.480	5532.241
Coefficient of Correlation:						
R		0.877435	0.950896	0.951177	0.951326	0.885665
$\overline{R}$		0.863522	0.942464	0.882323	0.935596	0.856547
Standard Error of Estimate:						
$\overline{S}$ (in logarithms)		0.267927	0.177609	0.332150	0.187579	0.274174
Standard Error of the Coefficients:						
	b	0.134621	0.089535	0.091887	0.145358	
	c	0.121726	0.082572	0.096513	0.187931	
	d		0.057051	0.051169	0.104929	
	e			0.144994	0.153270	
	f				0.124093	

Among the combinations of independent variables entering into the production equation, combinations I and V can be easily seen to be much less reliable than the others. The adjusted coefficient of multiple correlation is much lower and the standard error of estimate much higher for each of these two combinations than for any of the others. The standard error of the regression coefficients has been calculated for all the combinations except V (since it was noticed that V is not too good a combination). The values of the standard error of the coefficients show also that they are high as compared with those of the regression coefficients. It seems that a more reliable combination will be one of II, III, and IV. Judging from the values of the coefficient of multiple correlation and the

standard error of estimate, combinations II and IV are better than III. But from the point of view of reliability of the values of the coefficients in the equation, II and III are better than IV. Judged from both of these criteria, combination II is the best. Unfortunately, it leaves out the variables, productive livestock and tractors in use. For purposes of drawing conclusions, therefore, we shall rely heavily on II. But a few guesses will be made with respect to the variables left out in II from III or IV. The production equations represented by II, III and IV are given below:

$$\text{II.}\quad X_1 = 498.868\ X_2^{.2765}\ X_3^{.4253}\ X_4^{.2869}$$
$$\text{III.}\quad X_1 = 435.134\ X_2^{.2770}\ X_3^{.3896}\ X_4^{.2858}\ X_5^{.0468}$$
$$\text{IV.}\quad X_1 = 502.480\ X_2^{.3010}\ X_3^{.3639}\ X_4^{.2702}\ X_5^{.0372}\ X_7^{.0271}$$

Productivity of the Resource Inputs

The values of the regression coefficients (or the coefficients in the production equations) are given on the top of Table 2. One of the advantages of the type of function we are using is, as already pointed out, that the coefficients measure also the elasticities of production in respect to each variable. Thus using II, we can say that a 1 per cent increase in the population active in agriculture in the countries of the world, other variables remaining unchanged in value, results in a 0.28 per cent increase in net agricultural output of the world. Similarly, a 1 per cent increase in the weighted arable land area of the countries of the world will result in an increase of 0.43 per cent in net agricultural output per country, while a 1 per cent increase in fertilizer consumption will raise net agricultural output by 0.29 percent. The same relationship will hold in the case of decrease in the values of the variables. It is apparent from the values of the coefficients in the different combinations that the coefficients, b and d, namely, those relating to the variables, population active in agriculture and fertilizer consumption, have about the same value in combinations II and III. But c, the coefficient relating to land, goes down by about the value of e which enters into III but not into II. Among the coefficients, d (fertilizer consumption) seems to be the most stable in value, inasmuch as it has approximately the same value in all the three combinations, II, III and IV. Next in respect of stability in value is b (land weighted arable), followed by c. Needless to add, the values of b, c, and d are significant at the 1 percent level in combination II.

There are several conclusions that can be drawn from the figures in Table 2 about the use of resources within agriculture in the countries of the world included in the analysis. First, the values of the coefficients show that in the world at large, land, representing natural resources used in agriculture, has the highest elasticity of production. Material resources, as a group of inputs, seems to come next in respect of elasticity, followed by the human resource. The scale of importance of the human resource

may, however, change if its quality measured, say, by the managerial and entrepreneurial ability in different countries is included among the variables in the equation. No valid conclusion can, however, be drawn from this regarding economic efficiency in the use of these resources.

Secondly, the incorporation in the production equation of one or all of the variables, productive livestock, work stock, and tractors in use in agriculture does not seem to increase the predictive value of the equation. Besides, the values of the coefficients attached to these variables are not significant and cannot be relied on. This is rather interesting, specially if we remember that in the newly settled countries of the world both productive livestock and tractors contribute significantly to net agricultural income and the overall efficiency of agriculture. It is hazardous to draw any economic conclusion from this. One is tempted to conclude that in the world at large there is relative scarcity of land for extensive type of agriculture with emphasis on livestock and mechanization. As the variable, productive livestock, enters into the production equation in III, the value of the coefficient relating to land falls by about the same amount as the value of the new coefficient for livestock. In other words, land and productive livestock together contribute to net agricultural income, in equation III, by about the same proportion as land alone does in equation II. This *may* be interpreted as showing that the elasticity of production of the variable, land, goes down as livestock enters into farming. Again as tractors enter equation IV as a new variable, the value of the land coefficient goes down again and that of the labor coefficient goes up. This *may* show that tractors increase the production elasticity in the use of labor, but decrease that in the use of land and/or livestock. Such conclusions are, of course, hazardous, inasmuch as they are based on the changes in the values of the regression coefficients in the different combinations of independent variables, which *may* very well arise out of inter-correlation among these variables, and not from any underlying production relationships.

Thirdly, the values of the coefficients show that agriculture in the world is in a stage of diminishing returns in respect of the use of each of the seven resource-inputs included in our analysis. This corresponds with the general assumptions made in economic thinking about the nature of the returns in agriculture. Work done by others in this field also supports this view.[6] The implications of this are obvious. If returns to labor in agriculture are to be kept up, then either all the resource inputs must be increased simultaneously, or the inputs other than labor must be increased, keeping labor input at about the same level. Since, however, land

[6] For statistical evidence of the tendency to diminishing returns in agriculture in respect of use of labor, as computed by others, see Colin Clark, *Op. Cit.*, pp. 195-218.

input cannot be increased as much as the input of material resources, it is obvious that the former course cannot be pursued for any length of time. The latter course thus seems the more desirable. This certainly goes against the views of Colin Clark who advocates increasing the use of man-power in agriculture through a policy of letting agricultural prices rise in the world thereby making agricultural wages and incomes high enough to attract more men into this occupation. This is certainly not a good policy for most of the countries of the world.

Fourthly, it appears from the values of the sum of the coefficients in equations, II, III, and IV, that their sum is possibly equal to 1. All the three equations show a value close to 1. The regression equations have, however, explained about 90 percent of the variation in the dependent variable, the other 10 percent still remaining to be explained. If other variables like managerial and entrepreneurial ability are introduced into the equations, it *may* be that the sum of the coefficients may turn out to be more than 1. But the variables we have considered show that the returns to scale are constant in agriculture. This is in line with the findings of studies of production functions made in the U. S. by different economists, notably Earl Heady and Gerhard Tintner.[7] The returns to the scale of resources in agriculture are therefore constant and the same all over the world.

Marginal Productivities

Finally, the production equations enable us to infer what would be the most economical and optimum way to maximize the net output in agriculture in the world and in the underdeveloped countries. Conclusions can be drawn in this respect from the marginal productivities of the different items of resource input we have considered. In the previous pages we have been speaking in terms of efficiency in the use of each item of input, from the elasticity coefficient for each. But in order to deduce anything about additional resource inputs, we have to base our findings on the marginal efficiencies of the inputs. These can be studied from the figures of marginal productivities of the different items of input, which can be calculated easily from the production equations with the help of the following relationship:

$\partial X_1/\partial X_i = j \cdot X_1/X_i$, where X_i stands for any of the independent variables and j for its coefficient. The values of these marginal productivities ($\partial X_1/\partial X_i$) have been calculated at the geometric mean level of the different variables for the world at large and are presented in Table 3.

[7] Earl O. Heady, *Economics of Agricultural Production and Resource Use*, (Prentice-Hall, Inc., New York, 1952), pp. 349-381; and Gerhard Tintner, "A Note on the Derivation of Production Functions from Farm Records," *Econometrica*, xii, pp. 26-34.

The figures in Table 3 show by how much the net agricultural output will increase as the input of each item of resource is increased by 1 unit, 1 man in the case of agricultural labor force, 1 acre in the case of weighted arable land, 1 metric ton in the case of fertilizer and 1 standard animal unit of livestock. It appears from these figures that the marginal productivity of a ton of fertilizer is higher than that of one unit of any other item of resource input in the world at large, while that of a unit of productive livestock is the lowest. The marginal productivity of a tractor is second in order of value, followed in order by that of one man-labor, one acre of land and one unit of productive livestock per year. This order in the magnitude of the marginal productivities is mentioned, even though a strict comparison cannot be drawn among them, partly because the value of some of them is not reliable.

TABLE 3. MARGINAL PRODUCTIVITY OF THE DIFFERENT ITEMS OF RESOURCE-INPUT IN THE WORLD

Variable, or Item of Resource Input	Marginal Productivity (in U. S. $ per year) At the Geometric Mean Level Using Equation II	III	IV
Population Active in Agriculture	112.388	112.576	122.360
Weighted Arable Land	24.523	22.462	20.984
Fertilizer Consumption	2,367.843	2,386.127	2,231.930
Productive Livestock	—	7.484	6.211
Tractors in Use	—	—	1,429.088

What is perhaps most striking about the figures of marginal productivity is the tremendous disparity among the different inputs in this respect. If only the underdeveloped countries are included in the production equation, the disparity among the resource inputs in respect of marginal productivity will, in all likelihood, be still larger. The marginal productivities of labor, land, and livestock in the underdeveloped countries are likely to be much lower than in the world at large, while those of fertilizer and tractor in use will be much higher. The reason why this is likely to be so is because the average level of use of each of the first three inputs is much higher in relation to the agricultural output in the underdeveloped than in the advanced countries. The reverse is true in the case of the last two inputs. It must be mentioned in this connection that the figures of the marginal productivity of productive livestock and tractors in use are not reliable, since the regression coefficients of these variables are not statistically significant.

A word of caution must be put in here about the interpretation to be placed on the figures of elasticity and marginal productivity given in

Tables 2 and 3. The productivity figures all relate to net agricultural output per year, inasmuch as all the variables are annual magnitudes. Secondly, the figures of the marginal productivity signify the amount by which the net agricultural output of the world is expected to increase as a result of application of one additional unit of each of the inputs. This does not necessarily mean that this increase will come about in any particular country. Thus the application of one additional ton of fertilizer may not increase the annual agricultural output in any country by \$2,367.84. It may increase by more or by less, depending on the production pattern in agriculture in the country in question. But for the group of countries of the world included in the analysis, the additional output will average out at the above figure.

Thirdly, the production equations do not imply any causal relationships between the inputs and the outputs. They merely express a historical pattern of association established in the countries considered. The variables we are dealing with are macro-economic variables and do not, as such, measure the same things that these physical magnitudes stand for in micro-economic study of production functions. Thus the variable, X_4, namely, consumption of chemical fertilizers stands, in all probability, as a measure of a complex of inputs which can be described under the general name of capital invested in agriculture, with which it is undoubtedly highly inter-correlated. It is a fact that the countries which use proportionately more of chemical fertilizers are also those which have relatively more capital invested in agriculture in various forms. The productivity figure for X_4, therefore, includes those of other items of capital input, that are highly correlated with it. The undoubtedly high marginal productivity of fertilizer, as derived from the production equation, should therefore be interpreted as showing the amount by which the agricultural output will increase not necessarily as the direct result of the application of a ton of fertilizer, but also from a multiplier effect in respect of irrigation, improved seeds and cultural practices and such other variables highly correlated with fertilizer consumption. The safest use of the relationships and measures shown in Tables 2 and 3 is, perhaps, as indicators of the relative efficiencies and marginal productivities of the different items of input, rather than as accurate mathematical measures of these. It is in this direction that reliance should be placed on them for purposes of application to the field of policy.

Growth of Agricultural Output in the World

One use of the production equations that have been derived above is for estimation of the annual rate of growth of the agricultural output in the world. This rate can be easily calculated from the annual rate of

growth of each of the resource inputs included in the equation. Thus, by taking derivatives with respect to time, t, of both sides of equation II, we obtain

$$\frac{dX_1}{dt} = \frac{d(AX_2^bX_3^cX_4^d)}{dt} = b\cdot AX_2^{b-1}X_3^cX_4^d\cdot\frac{dX_2}{dt} + c\cdot AX_2^bX_3^{c-1}X_4^d\cdot\frac{dX_3}{dt}$$

$$+ d\cdot AX_2^bX_3^cX_4^{d-1}\cdot\frac{dX_4}{dt}$$

$$= b\cdot\frac{X_1}{X_2}\cdot\frac{dX_2}{dt} + c\cdot\frac{X_1}{X_3}\cdot\frac{dX_3}{dt} + d\cdot\frac{X_1}{X_4}\cdot\frac{dX_4}{dt}\cdot$$

or:

$$\frac{dX_1}{dt}/X_1 = b\cdot\frac{dX_2}{dt}/X_2 + c\cdot\frac{dX_3}{dt}/X_3 + d\cdot\frac{dX_4}{dt}/X_4.$$

$\frac{dX_1}{dt}/X_1$ stands for the rate of change of agricultural output, while $\frac{dX_2}{dt}/X_2$, $\frac{dX_3}{dt}/X_3$ and $\frac{dX_4}{dt}/X_4$ stand for the rates of change in the use of the inputs X_2, X_3 and X_4 respectively. Thus the annual rate of growth of X_1 can be calculated, with the help of the above relationship, by multiplying the rate of growth of each of the inputs, X_2, X_3 and X_4, by the corresponding coefficient (elasticity) and adding them together.

The average annual rate of change in the population active in agriculture has been estimated for most of the countries included in Table 1 from the statistics available for population active in agriculture in prewar and postwar years. Similarly, the annual rate of change in the consumption of chemical fertilizers has been computed as an average for these countries for the years 1947-48 to 1949-50. The figures of arable land and pastures showed that there is not much change in their total area between 1947-48 and 1949-50. Consequently, the rate of change of this variable has been taken to be 0. These rates along with the rate of growth of agricultural output are shown in Table 4.

It appears from Table 4 that the agricultural output in the twenty-two countries included in the production equation was increasing at an estimated average rate of 2.26 percent per year between 1948 and 1950. If we can generalize, with any justification, for the whole world from the performance of these countries, we can say that the world agricultural output was increasing during this period at a rate close to 2¼ percent per year. In recent years, the world population, excluding that of China and a few other countries for which statistics are lacking, has been growing at an estimated annual rate of about 1.22 percent. Thus the current rate of agricultural development is obviously above the minimum needed for taking care of the growth of population. It must not be forgotten, however, that a good part of this growth went towards reaching the level of

per capita output established in pre-war years. "In 1952-53 for the first time since the war, world agricultural production is estimated to have regained the prewar level per head of the population."[8] The question as to whether this rate can be maintained, if not increased, in future is one which cannot be answered from this study. It is obvious, however, that if the present rate of growth is maintained and if the rate of growth of population can be kept below it, there is no need for an alarmist view of the state of food and agriculture in the world.

TABLE 4. ANNUAL RATE OF GROWTH OF RESOURCE INPUTS AND NET AGRICULTURAL OUTPUT IN THE WORLD BETWEEN 1948 AND 1950

Items of Resource Input	Rate of Growth (percent per year) in the world, of:	
	Resource Inputs[b]	Agricultural Output
Weighted Arable Land	0.0	0.0
Population Active in Agriculture	0.9	0.25
Fertilizer Consumption[a]	7.0	2.01
Total		2.26

[a] Probably measures a complex of related factors.
[b] Computed from data given in the F.A.O. *Yearbook of Food and Agricultural Statistics, Production, 1952:* Vol. VI, Part 1 (Rome: 1953).

It is interesting to note here that the Food and Agriculture Organization of the United Nations has estimated a rate of growth of the world agricultural output at slightly over 2 percent per year. According to them, "in the last few years [since 1948] agricultural production has increased by rather over 2 percent annually, and slightly exceeded the growth of world population."[9] The results of our analysis run along the same line as the findings of the F.A.O.

Summary

An attempt has been made in this paper to fit a production function, linear in logarithms, to agriculture in selected countries of the world. It appears that the significant items of input contributing to the agricultural output of this group of countries are, fertilizer consumption, weighted arable land and number of people active in agriculture. The marginal productivities of these items of input have been computed. These figures show that the marginal productivity of a ton of chemical fertilizer is highest, that of one man-labor in agriculture is next and that of an acre of weighted arable land is lowest among the three. Items

[8] F.A.O., *The State of Food and Agriculture, 1953: Part I—Review and Outlook* (Rome: Food and Agriculture Organization, 1953). p. 15.
[9] *Ibid.*, p. 15.

of input like productive livestock, work-stock, tractors in use, did not show any significant regression. The production equation has been used to compute the average rate of growth of world agricultural output during the years 1948 to 1950. The rate is found to be 2.26 percent per year, against an estimated rate of population increase of the order of 1.22 percent per year in the world. Important policy implications may be derived from the analysis attempted in the paper.

AGRICULTURAL DEVELOPMENT IN MEXICO*

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ECONOMISTS have focused considerable attention in the post world war II period on factors that induce or accelerate the development of backward economies. Many of these so-called under-developed countries are characterized by a major dependence on primary industries (generally agriculture) and by low productivity of the human agent. These phenomena are so strongly evident that the economist sometimes concentrates too much attention on the backward agriculture and too little on the whole economy when considering proposals for development. Smaller and smaller proportions of a nation's working population employed in the production of food and fiber are implicitly or explicitly emphasized in much of the literature as requisite to, and indicative of, an expanding economy.[1] It is apparent from historical studies of developing economies that such expansion occurs with least socio-economic disruption if alternative industries are growing in a manner that their demand for the human agent in production is consistently in advance of the supply being released from agriculture. This phenomenon provides the incentive to develop and apply "labor-saving" techniques in farming.

Much of the recent interest in economic development has been directed toward neighbor Republics to the south. One may well question whether improvements have occurred in those countries, and if so, how such improvements were brought about. The present study is an effort to determine the direction and the rate of development in the agricultural segment of the Mexican economy over the twenty-five year period 1925-1950. In selecting the period it seemed necessary to go back of the depression of the thirties in order to avoid distortions brought by it and the recovery from the depths of that depression.[2]

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[1] The proposition, of course, requires limiting conditions which may or may not be in effect in particular countries.

[2] Much can and has been said regarding the unfortunate state of statistical data in Latin American countries. It should suffice here to acknowledge that many of the data that one would want for a study such as this are non-existent, that many of the data available have varying degrees of reliability, and most confusing of all, data are frequently published without sufficient information by which one can gauge their reliability. Such problems have in the past, and will continue, to restrict what can be

The agriculture of Mexico is diverse and large and many changes have occurred since 1925. Vast expenditures have been made in irrigation. New lands have been brought into cultivation. Evidence indicates there has been growth by the use of additional capital in machinery, equipment and in other improvements. Literature frequently refers to the application of better technology. The work and success of the Rockefeller Foundation in corn breeding and in other endeavors is widely known. Also, the expropriation of land in large quantities, the expansion of the *ejido* system, and the establishment of a system of agricultural credit,[3] have been forces whose impact, though not measured here, were of no small consequences to agriculture and to the overall economy.

The central question before us is: *how much of the increase in agricultural production in Mexico is to be explained by the use of additional resources, and how much of it has come from improvements in the state of the productive arts?* The investigation reported in this paper was undertaken in the belief that something may be done in answering this question by an empirical study of available data on agricultural inputs and output. An attempt was made to gauge the aggregate output against the aggregate input of agriculture in Mexico. It will be clear as we proceed that such an undertaking is confronted by serious difficulties.

There are many aspects of technological change, in this case related to agriculture, that cannot be entered into with the data at hand. It is not possible, for instance, to separate that part of an increase in output which has arisen from the application of "new techniques" (technological development as traditionally defined) from that part which has come from the application of previously known but unused techniques. Fortunately, our main interest lies in changes that "improve the economic well-being of people." In this connection the adoption of more productive techniques than those formerly used is relevant, whether these techniques are in this context "new" or "old."[4] The assumption is thus introduced for our purpose that a change of the ratio in which resources are combined, and where the change is accompanied by a more favorable ratio of output to input, is indicative of an improvement in the state of the productive arts.[5]

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done. In Mexico and other Latin American countries, as compared to the United States, data problems are greater in degree rather than different in kind.

It was not possible to secure data earlier than 1925 for the present study.

[3] To service the small land-holders created by the land reform movement.

[4] See Yale Brozen, *Determinants of the Direction of Technological Change*, Proceedings issue of the American Economic Review, May, 1953.

[5] Input is here used to mean an index which measures the aggregate of resources used.

It is possible that technological advance may make possible a greater output per unit of input with the same ratio combination of factors as previously used and no incentive to change the ratio. The usual case involves change in the ratio.

Agricultural Production

One may have some doubt that compiled data accurately measures total agricultural production in a country where considerable quantities of the farm produce are not marketed and, therefore, the statistics subject to the usual limitations in determining the amount of product that is consumed by the farm family. Also, one has the difficulty of definitions used at the time the different censuses and estimates were made. What is a farm and what is agriculture? Yet it is believed that changes registered consistently over a period of time furnish evidence of the direction, and may provide insight regarding the rate, of development in production.

It has been necessary to put aside the livestock products in our attempt to estimate aggregate agricultural output. There are marked inadequacies in livestock production data, and the economic pattern of livestock production was no doubt seriously disrupted as a result of the hoof and mouth disease in the country. Thus, our data are limited to crop agriculture which makes up about three-fourths of agriculture's total contribution to national income in Mexico.

There are several published series of crop production data. Six series of aggregate crop output were investigated. Three were from published reports by the United Nation's Economic Commission for Latin America, two from the publication by the International Bank for Reconstruction and Development (the Combined Mexican Working Party's report on *The Economic Development of Mexico)*, and one by N. L. Whetten in *Rural Mexico*. Even though these data are made up of different number and kinds of crops, and different price weights were used, the results were remarkably similar. Therefore the CMWP (Combined Mexican Working Party) index containing 24 crops is used for our purpose in this report, though the Economic Commission for Latin America's series is also given to facilitate comparison (see table 1).

Indications are that average annual production from 1945 to 1949 was about 60 percent greater than the average annual production from 1925 to 1929. Thus *the rate of increase in crop output averaged about three percent per annum* during the time-span covered by the study.[6] Noticeable curtailment of production occurred in the early thirties, so that expansion in output really materialized in the last fifteen years of the quarter century, and in that period was greater than 60 percent.

Studies have been made which seem to indicate that the extensive expansion of the *ejido* system in the thirties was accompanied—in those early years of the program— by diminished production efficiency on the lands

[6] Percentage increase recorded from the 1925-29 period average to the 1945-49 period average are divided by 20 to secure the average annual percentage increase.

expropriated. However true this may have been in the early years of the program, the facts are that total production improved markedly during the decade of the forties.

Change in Factor Inputs

The most reliable indication of change that has occurred in land as an input is furnished by the area from which crops were harvested (table 2). *The increase in land input has averaged slightly greater than one percent per year during the period studied, i.e. 23.2 percent greater in 1945-49 than in 1925-29.* One observes that area harvested was reduced below the 1925-29 average in the decade 1930 to 1940. It apparently declined in the early thirties, reached a low in the middle years of the decade and increased in the latter thirties.

TABLE 1. MEXICO: INDICES OF AGRICULTURAL CROP OUTPUT CHANGE BY FIVE-YEAR PERIOD AVERAGES FROM 1925 THROUGH 1949

Period	CMWP Output Index[a]	ECLA Output Index[b]
	Percent	Percent
1925–29	100.0	100.0
1930–34	91.3	94.8
1935–39	99.3	105.4
1940–44	127.9	132.7
1945–49	159.5	160.8[c]

[a] Combined Mexican Working Party, *The Economic Development of Mexico*, table 44, page 228 (contains 24 crops).

[b] United Nation's Economic and Social Council, Economic Commission for Latin America, *Economic Survey of Latin America, 1949*, table 16-A, page 439. (Quantum data in original was averaged by five-year periods and index computed.)

[c] 1949 based on a 4.5 percent increase over the 1948 quantum.

Area under irrigation increased proportionately more than did harvested area from 1940 to 1950 but, even so, accounted for only about one-fifth of the new acreage brought into cultivation during the period according to the CMWP report.

Under-developed countries are often characterized as having a "surplus" of man power and a "dearth" of the capital necessary for greater productivity on the part of the human agent. Factors which affect the rate of capital accumulation receive major attention, both by those who endeavor to construct theories of development and by those who would induce development of particular economies. Our immediate concern is with the change in agricultural capital requisites in Mexico in the second quarter of the twentieth century.

Data on imports furnish the most reliable indication of change in farm machinery, equipment and supplies used during the twenty-five year

period. Data were not available by which domestic production of farm "capital" inputs could be measured. Domestic production of such inputs was sharply limited during the period studied, and confined mostly to small implements, parts for machinery, some fertilizers and to some pesticides. However, it is true that in the latter years of the period, and more recently, the output of these domestically produced inputs, and also of may of those formerly imported, has increased substantially in the country and at an increasing rate. It is unlikely this phenomenon would seriously affect our results here since the increase in domestic production has been in the same direction and probably of similar proportions to that of imports.

Imports of machinery and equipment averaged only about one-half as large in the early thirties as in the latter twenties (table 2). This was increased somewhat in the 1935-39 period, but the average was still less than two-thirds that of 1925-29. The marked increase in imports of farm machinery and equipment occurred in the decade of the forties. The average annual imports during 1945-49 was almost four times that of 1925-29. The averages by five year periods, of course, hide the continuous annual increases from 1945 through 1949, i.e. imports in the early years of the period were less than the average, and in the latter years were greater than the average.

An effort was made to distinguish between factors exhaustible in one production period (supplies) and those exhaustible over a time-span of several production periods (machinery and equipment) by taking changes in fertilizer imports as representing changes that occurred in supplies as an input factor over the period studied. Imports of fertilizers were four and one-half times as great in 1945-49 as in 1925-29.

Thus the increase in capital equipment and supplies as an input factor (based on imports) averaged about 16 percent per year over the entire period covered by the study. The gains were much greater in the latter 15 years, and thus offset the decreases that occurred in the early thirties.

Census data of the economically active people engaged in agriculture were used to gain insight of changes in the labor input. Data for Mexico indicate that since 1921 total population has been increasing more rapidly than have the total economically active persons, and that those economically engaged in agriculture have increased proportionately less than either total population or the total economically active population. In other words *smaller and smaller proportions of the population are growing the foods and fibers produced domestically in Mexico.*

Estimates of changes in the agricultural labor force by five-year periods were arrived at by taking the census data of the economically active persons engaged in agriculture for each census beginning with 1921,

official annual estimates of total population from 1925 through 1949, and imputing the average number of the economically active in agriculture in each five-year period by relating the change in economically active in agriculture between census years to the change in the total population. From this an index with 1925-29 as base was constructed. According to the data the agricultural labor force was 16.3 percent greater in the 1945-49 period than in 1925-29, i.e. *average rate of increase in the labor force over the period studied was about eight-tenths of one percent per annum.*

TABLE 2. MEXICO: INDICES OF THE WORKING FORCE EMPLOYED IN AGRICULTURE, CROP AREA HARVESTED AND IMPORTS OF CAPITAL EQUIPMENT AND SUPPLIES FOR AGRICULTURE BY FIVE-YEAR PERIODS, 1925 THROUGH 1949

Period	Agricultural Working Force[a]	Cropland Harvested[b]	Agric. mach. and Equipt. Imports[c]	Imports of Agricultural Supplies[d]
	Percent	*Percent*	*Percent*	*Percent*
1925–29	100.0	100.0	100.0	100.0
1930–34	103.3	96.1	52.0	127.3
1935–39	107.1	96.6	65.1	331.8
1940–44	110.1	113.6	121.8	345.5
1945–49	116.3	123.2	396.7	456.8[e]

[a] Estimates of the agricultural working force by five-year periods were based on census tabulations of the agricultural working force, official annual estimates of total population, and the relative changes in each.

[b] Based on the area harvested as reported in *Boletin Mensual de la Direccion de Economia Rural*, Departmento de Economia y Estadistica from 1925 through 1941 and 1946 through 1949, and the *Annuario Estadistica de los Estados Unidos Mexicanos* from 1942 through 1945.

[c] Based on imports of agricultural machinery, equipment and tractors as reported in the *Annuario Estadistico* from 1925 through 1939 and in the *Comercio Exterior de Mexico*, Banco Nacional de Comercio Exterior, S.A. from 1940 through 1949.

[d] Based on fertilizer imports as reported in the *International Yearbook of Agriculture* from 1925 through 1939, and the *United Nation's Agricultural Requisites in Latin America*, 1950 report of joint ECLA/FAO working party for data from 1940 through 1948.

[e] Four-year average.

One can readily see from the data in table 2 that the ratio in which resources are combined in Mexico's crop agriculture has obviously changed, indicating a change in techniques applied to agriculture. This has resulted in the use of *less* land and labor (labor use decreased more per unit of output than did land) and *more* capital equipment and supplies in the ratio—thus pointing out the direction of development. Agricultural crop output in 1945-49 was about 60 percent greater than in 1925-29. In producing this 60 percent greater output only 16 percent more labor and 23 percent more land was used, but over 300 percent more capital equipment and supplies was used. Inputs of labor and land per unit of output were 27 percent and 23 percent less respectively in 1945-49 than in 1925-29 (table 3).

TABLE 3. MEXICO: INDICES OF CHANGE IN LAND AND LABOR USED IN AGRICULTURE PER UNIT OF OUTPUT, 1925 THROUGH 1949

Period	Land Use per Unit of Output	Labor Use per Unit of Output
	Percent	*Percent*
1925–29	100.0	100.0
1930–34	105.3	113.1
1935–39	97.3	107.9
1940–44	88.8	86.1
1945–49	77.2	72.9

Development

Since the use of capital equipment and supplies per unit of product rose, while the use of land and labor fell, over the period studied, can one tell whether output measured against total inputs has increased, decreased, or remained constant? An effort (admittedly rough) has been made to gain insight bearing on this fundamental question.

The immediate problem is how to weigh the inputs when computing a "total input" index. One must work piecemeal with sharply limited data relevant to such weights. The two sets of weights used in the present paper are given in table 4. Since the 1930 and 1940 census gives a total

TABLE 4. MEXICO: WEIGHTS FOR SPECIFIED FARM INPUTS BASED ON DATA FOR THE CENSUS YEARS, 1930 AND 1940

Productive factor	Weights as Percentage of Total	
	1930	1940
	Percent	*Percent*
Land, buildings & hydraulics[a]	31.4	23.0
Marchinery and equipment[b]	1.5	1.8
Supplies[c]	.6	.5
Labor[d]	66.5	74.7
Total	100.0	100.0

[a] The cost of the land factor was computed at 12.5 percent of the total value reported in each census year. Buildings and hydraulics were computed at 12.5 percent of total value (interest on invested capital) plus a 5 percent depreciation charge.

[b] Machinery and equipment charges were made at the rate of 12.5 percent of the total value reported on farms (interest) plus a 10 percent depreciation charge.

[c] The 1940 imports of total fertilizers were valued at 16.50 pesos per cwt. and the result was doubled to secure an estimation of supplies used during the year. The 1930 imports of fertilizer were valued at 23.70 pesos per cwt. (the percentage relation of nitrogenous fertilizer prices on the New York market in 1930 and 1940 applied to the 1940 price) and the results doubled for an estimation of supplies used in 1930.

[d] It was considered each adult male worked an average of 249 days per year. The economically active in agriculture for the respective census years were adjusted in a manner to weigh all women over 16 at ¾, and boys and girls in the force under 16 at ½. The respective daily wage rate for each census year was then applied to secure the total value of the labor force.

value figure for land, fixed assets and for machinery and equipment on farms, data were utilized to construct weights which may roughly indicate the importance of the different input factors in production for those two census years (see footnotes to table 4 for the methods used). One observes that land and fixed assets, relative to total inputs, has a greater weight in 1930 than in 1940 and the opposite for labor. The machinery and equipment weight was slightly greater in 1940.

By applying the 1930 and 1940 weights to represent the 1925-29 and 1935-39 average inputs respectively, computing values of each input for

TABLE 5. MEXICO: CHANGE IN AGRICULTURAL CROP PRODUCTION AS COMPARED TO THE CHANGE IN AGGREGATE PRODUCTIVE SERVICES USED BY FIVE YEAR PERIODS, 1925 THROUGH 1949

Periods	Aggregate Input Index		CMWP Crop Output Index	Output per Unit of Aggregate Input	
	I[a]	II[b]		Index I[c]	Index II[d]
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
1925–29	100.0	100.0	100.0	100.0	100.0
1930–34	100.4	100.1	91.3	90.9	91.2
1935–39	104.5	103.7	99.3	95.0	95.8
1940–44	112.8	111.7	127.9	113.4	114.5
1945–49	124.7	126.6	159.5	127.9	126.0

[a] The 1930 weights were used to represent input factors in the 1925–29 period. Index numbers of change in each of the input factors as presented in table 2 were applied to the respective weights, the inputs were then summed by periods, and the aggregate input index computed.

[b] The 1940 weights were used to represent input factors in the 1935–39 period and computations were made as described in footnote [a].

[c] Aggregate input index I divided by crop output index in respective periods and the result multiplied by 100.

[d] Aggregate input index II divided by crop output index in the respective periods and the result multiplied by 100.

other periods according to the individual indices (table 2) of change between periods, summing and converting the aggregate sums to indexes with 1925-29 at 100 we obtain the aggregate input indices shown in columns 1 and 2 of table 5. In spite of the different weights applied, the two aggregate input indices show a similar magnitude of change over the twenty-five year period. These indices indicate aggregate inputs increased by about 26 percent from 1925-29 to 1945-49, as compared with the 60 percent increase in agricultural crop production. Dividing the CMWP output index numbers by respective index numbers of each of the two aggregate input indices we secure the two indice series of output per unit of input shown in the right hand columns of table 5. The data indicate that a unit of aggregate input was producing roughly one-fourth more product in the latter part of the forties than in the latter twenties.

To summarize, the greater quantity of inputs in 1945-49 accounts for 26 percent of the 60 percent greater agricultural output. The remaining 34 percent increase in output is attributed to better techniques that improved the productiveness of the resources in the aggregate. This 34 percent gauged against the 126 percent indice of aggregate inputs in the 1945-49 period gives about 27 *percent more product per unit of input in 1945-49 than in 1925-29.*

ASPECTS OF MULTIPLE-OWNER INTEGRATION IN THE BROILER INDUSTRY*

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THE rapidly expanding broiler industry and its peculiar quasi-integration arrangements have long been causing concern to many observers. Recent studies of the industry in Georgia and Mississippi have further documented the rather unique arrangements between producers and feed-dealer financiers.[1] In Georgia, which is the nation's leading broiler state, about two-thirds of the production is under one or more contractual arrangements by which the feed-dealer guarantees either some form of fixed return or no loss to the grower. In Mississippi over four-fifths of the growers were operating under an open-account contract with their feed-dealers. In both areas, bank financing or grower self-financing were practically non-existent.

In both of the above areas it also was found that the feed-dealer was active in making the various production and marketing decisions. The feed-dealer and his service men advised on placement, production practices and the timing and manner of marketing the birds. Dealers, in addition, often had standing arrangements with particular processors. In a very real sense, then, these dealers without outright ownership had accomplished an effective vertical integration in the broiler industry from the growing through to the processing of the product.

Many have looked with alarm upon this development of integration and control. Comments have been made to the effect that the cotton share-cropper merely has been replaced by the broiler share-cropper. Many results are assumed or implied from this development. These might be summarized as follows:

1. In exchange for a guaranteed return the grower loses his managerial freedom. With the loss of this freedom, the grower loses the incentive to improve his practices and his product.
2. Such integration under the feed dealer's control is essentially monopolistic and therefore increases costs, prevents needed adjustments and results in misallocation of resources and incomes.

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[1] W. E. Christian, Jr. and Paul T. Blair, *Broiler Production, Financing and Marketing in Mississippi*, Mississippi Agricultural Experiment Station Bulletin 514, March, 1954 and W. W. Harper, *Marketing Georgia Broilers*, Georgia Experiment Station Bulletin 281, July, 1953.

Results of a Comparative Study

One of the difficulties facing social scientists is that of having a "control" case to be used in comparison with an "experimental" case in order to measure the effects of measures undertaken in the experiment. Such studies are difficult to make in the broiler industry because of the many dissimilar factors that exist in each different situation. A study of the broiler industry has been made, however, which approximates the theoretical ideal study in similarity of most phenomena except those under analysis. This study compares some of the effects of integration in the broiler industry with the outcome where there is practically no integration. Both areas of broiler production are in Indiana, and analysis of them discloses some very interesting differences.[2] For the sake of labeling them we shall call the two areas A and B.

The industry in Area A could be characterized as non-integrated. Producers were relatively free agents in almost all important aspects of decision making. Although they secured large amounts of credit from various sources, conditional sales contracts were little used. The ownership of the birds remained with the producer. There was an essential independence of the grower from his feed-dealer. When the birds were ready for market the grower chose his outlet from among several independent buyers.

The industry in Area B, on the other hand, could be characterized as an integrated one. Producers were contractually tied to their financiers (who were usually their feed-dealers). The title to the birds rested with the feed-dealer who extended credit. The feed-dealer, through field men who made regular visits to the producers, generally helped in the making of the important decisions. The feed-dealer was also the marketing agency for his growers. Tables 1 and 2 compare some of the characteristics of the two areas.

What effect, if any, did this difference in institutional arrangements between these areas have on production practices and results? Several of the possible measuring sticks that might be used to answer this question are summed up as follows:

1. In both areas, broiler production was a relatively new enterprise. Nearly three-fourths of the growers had started operation since World War II. Of the two areas, Area B had a larger proportion of relatively new growers. As of August, 1952, 58 percent of the growers in Area A and 82 percent in Area B had been in business

[2] See *Broiler Financing in Indiana* by M. I. Bevins, Unpublished thesis, Purdue University, January, 1954. The basic data for the analysis was secured from a random sample of producers stratified by location, capacity and enterprise age and from a complete survey of feed dealers and other financiers serving these areas.

TABLE 1. TERMS OF SALE BETWEEN BROILER GROWERS AND FEED DEALERS FOR FEED PURCHASES, TWO INDIANA AREAS, AUGUST, 1952

Type of Financial Arrangement	Area A		Area B	
	Percent of		Percent of	
	Growers	Broilers	Growers	Broilers
Cash in 30 days	74	81[a]	6	9
Open Account	26	19	6	
Interest-bearing contract	0	0	49	45
Non-interest-bearing contract	0	0	20	25
Profit-share or guarantee	0	0[b]	19	21

[a] Source of growers' cash for payment within 30 days: Growers' own capital—19%; P.C.A.'s and Credit Unions—42%; Commercial banks—39%.

[b] There was some evidence of one or two of these plans in operation though they did not show up in the sample.

less than seven years, and production was still expanding in both areas.

2. There were 24 feed-dealers in Area A of which 18 also supplied chicks. There were 18 feed-dealers in Area B of which 17 supplied chicks. However, growers in Area A tended to purchase chicks and feed from different suppliers and often to patronize more than one source for each. Practically all growers in Area B, on the other hand, purchased chicks and feed from the same supplier and patronized only a single source (Table 2).

TABLE 2. SOURCE OF SUPPLIES AND TYPE OF MARKET OUTLET IN TWO INDIANA AREAS, AUGUST, 1952

	Area A	Area B
	Percent of Producers	
Purchased feed from more than one source	16	1
Purchased Chicks from more than one source	36	4
Contacted two or more buyers before selling	48	0
Type of Buyer used:		
Independent	100	4
Contractor	0	96

3. In brood size there was no significant difference between areas. The average size of brood was 8,388.
4. In the number of broods placed per year there was no significant difference. The average of both areas was 3.
5. In the uniformity of breeds being produced within the areas, there was a difference. More different breeds were being grown in Area A.
6. In the feed conversion being realized by the growers there was no significant difference. The average was 3.4.

7. In the rate of chick mortality there was no significant difference. The average was 8.1 percent.
8. In the extent of broiler specialization (as measured by the percentage of total work units which was derived from broilers) Area B was more specialized (57 percent compared with 48 percent). However, this was largely due to the smaller total farm unit in Area B rather than from the size of the broiler enterprise.
9. Area A had better housing and more automatic equipment. But at least part of this might be due to the fact that Area A was about 200 miles further north than Area B and therefore perhaps needed more elaborate housing.
10. No conclusion can be made concerning the comparative management ability that was residual with the grower *himself*. The management *results* in the two areas were similar. However, as will be shown, the growers in Area B received much more management assistance from their feed suppliers than did those in Area A.

If the above can be accepted as indications, it must be concluded that there was very little difference between the two areas in the efficiency of the production operation.

Two other important points need to be explored—prices received by growers for their birds and the prices paid by growers for their supplies. Usually prices received in Area B were slightly below those received in Area A. During 1952-53 the differential was about one cent. In interpreting this figure, however, the location of the two areas must be kept in mind. Area A is nearer to large metropolitan outlets than Area B.

Feed prices were the only element of cost that was studied (most studies conclude that feed makes up about two-thirds of total costs). Here the difference was significant and substantial. The average feed price reported by dealers in Area A was $97.46 and that reported by dealers in Area B was $105.71—a difference of $8.25 per ton.[3]

Several factors that might account for this difference were analyzed. These factors and their effects can be briefly summarized as follows:

1. Differences in the composition of feed. There was no difference in the average protein content of feed. There was, however, more medication in the feed used in Area B than in that used in Area A. A small part of the higher price of feed in Area B might be accounted for by this factor.
2. Difference in transportation costs of feed into the area. Difference in distances and agencies of transportation were involved. However,

[3] Feed prices here referred to represents the lowest possible price which could be obtained by deducting all possible discounts and weighted by the tonnage of feed sold.

when all were considered, direct transportation costs into Area B were probably lower than into Area A. The extent to which major feed manufacturers might have practiced freight absorption and preferential pricing was not ascertained.

3. Differences in feed handling practices. Bulk vs. bag handling and rail head vs. dealer delivery, if different between the two areas, might affect the price. No definite patterns or effects which could be attributed to this factor were found.
4. Differences in the discount practices. Although the details of discount practices varied widely, when the over-all situation was considered there was no real difference between the two areas.

From such analysis it was concluded that a large proportion of the difference in feed prices must be due to the differences in the institutional arrangements between the two areas. These two differences could be stated as follows:

1. The actual product sold was not feed alone but rather it was feed *plus* a bundle of services. From this viewpoint, the product being priced in Area B was substantially different from that in Area A. In Area B, it was feed *plus* financing *plus* advisory management services *plus* marketing functions. In Area A, although some of the above were offered, the accessory bundle of services was essentially much smaller.
2. Many aspects of the competitive situation were essentially different. Dealers in Area B have their growers contractually tied to them; they are their growers' creditors; and they are their growers' marketing agency as well as supplier. Many of them have strong personal connections because of their direct concern with growers' problems. The dealers in Area A do not have these ties and relations with their growers in the same degree.

How much of the difference in price could be attributed to the difference in service and how much to the difference in the competitive situation? No definite answer to this can be given. There were indications, however, that not all of the price difference could be accounted for by the difference in product or service as outlined in (1) above. For example, when comparison was made of the difference between the two areas with respect to the extension of credit, it became apparent that the costs of complete open account credit in Area A were probably about equal to non-interest bearing contracts of Area B. In this comparison, however, feed prices were still $5 a ton higher in Area B than in Area A. Within Area B itself, although there was little difference in the service bundle offered with feed, there was no logical relationship between feed cost

and the amount and arrangement of the credit extension. In terms of the limited comparison available where credit policies were similar in the two areas, feed prices in Area B were considerably higher than those in Area A.

The differences in feed cost and financing cost were substantial under different arrangements (Table 3). This table also offers a comparison between the areas, since the cash and open account situations predominated in Area A and the contract situations predominated in Area B.

TABLE 3. COSTS OF PURCHASING AND FINANCING FEED FOR A 10,000 BIRD OPERATION ASSUMING AVERAGE FEED CONVERSION AND AVERAGE FEED PRICES, DIFFERENT FINANCIAL ARRANGEMENTS, INDIANA, 1952.

	Methods of Payment to Feed Dealer			
	Cash	Open Account	Contract with Interest	Contract without Interest
Cost of Feed	$4,995	$5,031	$5,644	$5,206
Direct cost of finance	25[a]	0	85[b]	0
Total	5,020	5,031	5,729	5,206

[a] Half bank financed for two months at 6 percent; half (last month) carried on 30 day open account.

[b] Credit need for 3 months estimated in advance and carried entire period at 6 percent.

The Nature of the Competitive Structure

The nature of competition is clearly suggested by this study. Here is a situation where there were only slight differences in the number of firms meeting in the market. Approximately two-thirds of the feed was sold by one-fifth of the firms in each of the areas. Lowest feed prices were charged in Area A by the dominant firms, however, with smaller firms charging higher prices. In Area B, highest prices were charged by dominant firms with smaller firms charging lower prices. Apparently the use of price alone as a means of attracting customers had differing success between the two areas.

The real difference in competition was in the form of the relationship existing between dealers and growers. In Area B the growers were tied to the dealers by contracts, and the dealers in Area B were partners with their growers in production management. In addition, since the dealers marketed the birds for them, the growers feared that they would have no market outlet if they severed their contractual ties with the dealers. Furthermore, there was some evidence revealed in the study that growers in Area B were encouraged to remain in debt to the dealers in order to prevent their changing dealers. In addition, salesmanship of dealers in Area B took the form of a highly personalized relationship. A feeling that "he has taken care of me in the past and will in the future" seemed to

exist. In Area A, however, there was little evidence of any of these forms of dealer control and influence over growers.[4]

If one recalls the definition of a market as "that area in which the same buyers and sellers meet," one would conclude that Area B of this study is one in which only one seller (the dealer) meets with buyers (his growers) in each sub-market. It would be an example of monopoly with a "limit price." This limit would be that price above which the tacit collusion among dealers would break down. In addition to this monopolistic subdivision of the market, there is the product differentiation brought about through the offering of a package including a variety of services. Also, if the dealer, in effect, buys the finished birds for resale into the normal market for broilers, there is also a monopsonistic element present in the situation.

One consequence of this monopolistic structure in the broiler industry is immediately observable when comparison is made of the distribution of income between dealers and growers in the two areas. The assumptions of theory, that monopoly power enhances income, are apparently supported. The dealers in the integrated industry of Area B charged a higher price for feed, $8.25 a ton average, than was charged in Area A. They sold a more differentiated product for this price (indicating the probable existence of product competition along with some price competition as there is generally assumed to be in the areas of imperfect competition).

It should be noted that further methods of dealer exploitation of growers were evident. Growers in Area B were financed by the dealers. It appeared that additional profit accrued to dealers in Area B from this practice. Also, it was possible that dealers in Area B profited from the handling of the marketing of birds, but this conclusion is only inferential. In any event, growers in Area B received less income per bird than did growers in Area A and this difference was largely attributable to the integrated nature of the broiler industry in Area B.

Longer-run Dynamic Consequences

There are further consequences which should be considered before any judgments are made as to the social desirability of this type of industry structure. These are two fold. First, what are the long range consequences of broiler industry integration in a dynamic situation? Second, could the broiler growers in Area B have existed at all (or at least at the same level

[4] In Georgia dealers have arranged both formally and informally to exchange information on the efficiencies of various growers. Growers who are "blacklisted" find it quite difficult or impossible to get a dealer to place chicks with them. Harper, *op. cit.*, p. 27. There was no evidence showing that the practice of "blacklisting" was employed in Area B of this study.

of efficiency) in the absence of dealer control? Neither of these questions can be answered clearly and simply on the basis of results determined in this study. Nevertheless, there are indications of the probable answers.

In the long run, total costs—including costs of raw product production, processing and marketing—in an industry where integration has taken place are likely to be lower than where no integration has taken place. This is likely to be so because the integrated operation effects a pooling of talents. This could also be true for the areas of broiler production where the integration may pool the efficiences of the growers, feed-supplier-financier, and processors. The individual grower's risk position may be reduced and management levels may be raised. Total industry capital costs might be reduced where the dealer is the financier since he would have more intimate knowledge of the credit problems of the industry and would be in a position to pool his risks. Marketing and processing costs might be reduced because of a closer coordination of supply movement and other factors. Under such circumstances the industry of unintegrated areas may be put under additional pressure as a consequence of interregional competition coming from the integrated areas. This would be especially true if the integrated area, with its potentiality of a greater reserve of capital, could carry the burden of low prices in times of over-supply better than an area of independent growers with limited abilities to absorb such low prices for an appreciable time.

Areas with an integrated industry also are likely to be more stable than nonintegrated areas. This would tend to be the case when arrangements between dealers (as marketing agents) and processors causes both to become more interested in a continuing level of supply. In addition, feed used in broiler production in largely a manufactured product, and dealers are the distributors for nationally or regionally marketed products. The self interest of feed manufacturing firms would also favor stability in the level of production and such firms may take steps to assist their dealers in times of distress. Nearness to surplus feed areas *per se* might not be so important.

It has already been pointed out that there was no indication of the various contractual or guarantee arrangements reducing the rate of technological progress. There was no significant difference between the two areas in feed conversion and mortality and other management factors. Conceivably, to the extent that the dealers in the integrated type area enforce requirements of progressiveness and make progress possible through management assistance offered, growers would eventually be as much or more progressive than independent growers. If uncertainty should be lessened for growers and dealers in the integrated operation, there would be greater willingness to introduce capital and labor-saving tech-

niques because of the likelihood of long run gain coming from their employment.

Is integration necessary for the existence of the broiler industry in certain regions? In the case of Area B, the region was one of poor farm land and few alternative employment opportunities. The economic status of many of the growers in the area was such that they probably would not have been granted credit for initiating their broiler enterprises from conventional lending institutions. In many areas, the question can be asked whether the necessary management ability was available without outside aid. Under these circumstances, the broiler growers, dependent though they might be, probably were in a better economic position as a result of the entrepreneureship of the dealers than if no such development had taken place.

In summary, the study tends to measure some of the consequences of vertical integration where ownership remains separate and this differs from vertical integration under one ownership. The integrated industry may have lower total costs. The shares of income within the industry tend to be divided in favor of those empowered. Such a distribution pattern would have to find its justification as a cost paid by various industry segments for reduced risk, increased stability, and availability of productive opportunity.

A STUDY OF FARMERS' REACTIONS TO UNCERTAIN PRICE EXPECTATIONS[1]

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Uncertainty theory in economics, while not perhaps complete,[2] is nevertheless far ahead of the empirical work necessary to test it. The study described in this note is submitted as a contribution to the literature concerned with verifying uncertainty theory. The specific aspect of the theory that is in question here is the nature of the discounting process that farmers utilize when faced with price uncertainty. Knowledge of the nature of the discounting procedure is of interest to practice as well as to theory, for policy that is based on an inaccurate conception of farmers' reactions to uncertainty need not be expected to produce the results hoped for when it is adopted.

The ultimate concern of this study is productivity in agriculture. Production economics incorporates uncertainty theory because of the factor of time. When resources have to be committed before the outcome can be known, some assumptions about economic returns must be made. But the expected returns are uncertain, and how the farmer reacts to this uncertainty will determine, other things being equal, how productive he is.

In this study no distinction is made between the words "risk" and "uncertainty," thereby following the practice of Hardy, Hicks, D. Gale Johnson and Arrow.[3] The phenomenon defined by Knight as "risk" quite clearly is a measurable quantity that may be taken into objective consideration while making plans. This study is concerned, not with Knight's "risk" but, with reactions to the type of situation denoted by Knight as "uncertainty," i.e., where information is so incomplete that no statistical or *a priori* pronouncement can be made about the outcome, and where each

[1] These remarks derive from the author's doctoral dissertation: "Some Aspects of Expectation-Forming in the Face of Uncertainty in Agriculture with Special Emphasis on Farmers' Uncertainty Preferences as Revealed Empirically in Clark County, Ohio," The Ohio State University, 1953.

[2] There has been a great deal written during the past two decades on uncertainty theory. Rather than list all of the works consulted in preparing this study, suffice to refer to an annotated article on the subject by J. K. Arrow, "Alternative Approaches to the Theory of Chance in Risk-Taking Situations," *Econometrica,* Vol. 19, No. 4 (Oct. 1951), pp. 404-437.

[3] C. O. Hardy, *Risk and Risk-Bearing,* Chicago: University of Chicago Press, 1923, pp. 46, 53-55. See also J. D. Black, *Introduction to Production Economics,* New York: Henry Holt and Co., 1926, pp. 622-639, for a discussion that follows Hardy; J. R. Hicks, "The Theory of Uncertainty and Profit," *Economica,* Vol. 11 (May, 1931), pp. 170-189; D. Gale Johnson, *Forward Prices for Agriculture,* Chicago: The University of Chicago Press, 1947, p. 38, note; J. K. Arrow, "Alternative Approaches to the Theory of Choice in Risk-taking Situations," *Econometrica,* Vol. 19, No. 4 (Oct., 1951), pp. 404-437.

event is characterized by a considerable amount of uniqueness. Although it may be possible in a general way to rank outcomes as more or less risky, or uncertain, such ordinal measurements are not usually very precise, and are commonly thought to arise from shadowy hunches as well as from concrete observations of the real world.

If the classical competitive economy with fully employed resources is chosen as the model, it can be shown that the rational person will discount an uncertain outcome at a rate appropriate to reduce the uncertainty to a certainty equivalent.[4] Attempts to demonstrate this principle empirically have not been altogether unanimous in their results.[5] It was in an effort, therefore, to get more evidence about this theoretical point that the following study was undertaken.

The theory states[6] that the entrepreneur discounts the most probable price for uncertainty to obtain a "representative" price or an "effective" price. However, Brownlee and Gainer, and Williams found that within the limits of their measurements the opposite seemed to be true.

This study assumed that if farmers regularly discounted an uncertain income sufficiently to make it a certainty equivalent, they would be glad to have a lower certain price for the product being sold if they had the opportunity, than the higher one they expected with some uncertainty. A schedule of questions was drawn up designed to put the above theoretical point into relief.

The sample of farmers to be interviewed was selected randomly from a list of farms 50 acres and over in size in Clark County, Ohio. The county lies in an area that is typical of Corn Belt agriculture. There are fairly homogeneous soil associations and the farms produce mainly livestock and dairy products. Interviewing took place during the month of April and 43 records were completed.

It was anticipated that the farmer's outlook at the time of the interview might make a difference to his apparent attitude toward uncertainty. If he were somewhat buoyant about the possible future outcome, he might prefer to take a chance on uncertainty rather than accept a certain price appropriately discounted. This apparent preference for uncertainty would

[4] J. R. Hicks, *Value and Capital*, Oxford: The Clarendon Press, 1946, esp. pp. 115-127.

[5] O. H. Brownlee and Walter Gainer, "Farmers' Price Anticipations and the Role of Uncertainty in Farm Planning," *This Journal*, Vol. XXXI, No. 2 (May, 1949), pp. 266-275; D. B. Williams, "Price Expectations and Reactions to Uncertainty by Farmers in Illinois." *This Journal*, Vol. XXXIII, No. 1 (February, 1951), pp. 20-39; A. Dewey Bond, "Producer Responses to and Attitudes Toward Federal Price Support Programs for Potatoes," Doctoral Dissertation, Michigan State College, 1953; Gordon Ball, "A Study of Farm Expectations," Master's Thesis, Iowa State College, 1950.

[6] Hicks, *Value and Capital*, op. cit., pp. 115-127, and O. Lange, *Price Flexibility and Employment*, Bloomington: The Principia Press, Inc., 1944.

not mean that he did not use the discounting procedure as set out in the theory, but that the farmer's anticipations were so optimistic that he believed he had more to gain than to lose by taking a chance. If the farmer entertained a pessimistic attitude, however, he would be inclined to favor acceptance of the discounted price out of fear that the outcome would turn out worse than he felt was most probable.

The first four questions of the schedule attempted to elicit information concerning the farmer's outlook. Each respondent was asked what he considered to be the outlook for his own prospects, for the price level of commodities farmers buy and sell, respectively, and for prospects in the country as a whole. The plan was to eliminate in the refinement of the results those who were neutral or optimistic in order to isolate the farmers' attitude toward uncertainty.

TABLE 1. ECONOMIC OUTLOOK, BY "MOST IMPORTANT ENTERPRISE,"[a] 43 FARMERS, CLARK COUNTY, OHIO, APRIL, 1953

Enterprise	Economic Outlook[b]			
	Pessimistic	Neutral	Optimistic	Total
Hogs	9	9	2	20
Dairy	14	1	0	15
Other[c]	4	3	1	8
Total	27	13	3	43

[a] Enterprise considered most important to the firm.
[b] Economic outlook as revealed through the answers to the first four questions of the schedule.
[c] Other consists of 2 corn, 4 beef, 1 soybeans and 1 potatoes enterprises.

Attention was given next to the product of the enterprise that the farmer felt was most important from an income point of view. Each farmer was asked what price he thought was most probable for that product the following fall. After several questions of a minor nature had been asked, the farmer was requested to name the lowest certain price that he would take instead of the uncertain one that he had indicated earlier. If the *certain* price expressed was lower than the price considered "most probable" the farmer's behavior would be in accordance with the theory.

Table 1 summarizes the results of the questions of the schedule, designed to reveal the farmers' outlook. It shows that 27 farmers, or 62.8 percent of the total, had to be classified as pessimistic while the others were neutral or optimistic.

There is the chance that some of the 27 farmers classified as pessimistic about prices might be optimistic on other grounds,[7] and that their hope-

[7] Some farmers, when replying to the question respecting their outlook for this year volunteered the information that it was better because "I am out of beef into dairy,"

fulness might affect their apparent attitude toward discounting for uncertainty. Among the 27 farmers designated as pessimistic, there were 16 who said that they expected a worse outcome for their most important enterprise than they had experienced during the past two years. In order to eliminate all but those who were definitely pessimistic, only the records of these 16 farmers were retained for further analysis, while the remainder of the sample was set aside.[8]

When it had been ascertained what the expected price was, the farmers were asked what *certain* price they would take rather than continue to expect the one already given, but with some uncertainty. In every case the farmers would take a *certain* price that was not lower, as postulated, but equal to or higher than the price considered most probable. This unusual outcome suggests the following:

First, the suspicion that farmers may have named an unduly low price as most probable on account of their pessimism is not without foundation. There were 8 cases all told where the farmer named the lower end of the range of expected prices as the most probable. Such individuals would be irrational to accept a *certain* price that was even lower than the one they had named.

Second, those who did not name the lower end of the range as most probable, may have named a low figure, nevertheless, on account of their pessimism. Assuming that the subjective probability distribution was normal, the midpoint of the range of expected prices should give a close approximation to the price actually expected. Correlation analysis was applied to the most probable price and the midpoint of the range of expected prices to establish whether or not a relationship existed.

The two most common enterprises in the sample, hogs and dairy, were handled separately and the correlation was calculated for all of the farmers in the sample who had named the measures needed for the calculations. The results are summarized in Table 2.

Since these coefficients are fairly high the arbitrary criterion is established that those farmers whose most probable price falls below the midpoint of the range of expected prices either did not understand the question or did not name the price they really thought was "most probable." The latter farmers may have suggested instead a price somewhat lower than they thought they might receive with the greatest likelihood. They were set aside, therefore, with the previous ones, and thus ten records remained.

or "the last two years were dry, I think that this year will be better." The buoyancy they felt because of these non-price considerations might be reflected in their answers concerning their preference or non-preference for a certain price.

[8] There were 17 who indicated a "worse" outcome, but one of them was unable to formulate a most probable price, hence his record could not be included with those that were subsequently refined further, so it is excluded here also.

TABLE 2. COEFFICIENTS OF CORRELATION OF MOST PROBABLE PRICE AND THE MIDPOINT OF THE RANGE OF PROBABLE PRICES, BY "MOST IMPORTANT ENTERPRISE," 39 FARMERS, CLARK COUNTY, OHIO, APRIL, 1953

Enterprise	Number of Farmers	Coefficient of Correlation	Percent of Explained Variance
Hogs	18	+0.79[a]	62.59
Dairy	14	+0.81[a]	66.09
All Farmers	39	+0.99[a]	97.81

[a] Significant at the 1 per cent point.

These were from persons who indicated that they were pessimistic both in general and about their own farm's outcome in particular. They named a most probable price, in addition, that was equal to or in excess of the midpoint of the range of expected prices. Yet they either would accept a *certain* price under no circumstances, or would do so only if a premium were paid. These results are summarized in Table 3.

TABLE 3. SUMMARY OF DISTRIBUTION ACCORDING TO SPECIFIED CRITERIA,[a] BY "MOST IMPORTANT ENTERPRISE," 43 FARMERS, CLARK COUNTY, OHIO, APRIL, 1953

Enterprise	No. Willing to Accept a *Certain* Price[b]	No. Unwilling to Accept a *Certain* Price[c]	Total Columns 1 & 2	Total All Others	Total of Farmers
	(1)	(2)	(3)	(4)	(5)
Hogs	1	2	3	17	20
Dairy	3	2	5	10	15
Other[d]	2	0	2	6	8
Total	6	4	10	33	43

[a] The criteria are as follows: first, a grade of pessimistic as regards the economic outlook in general; second, a pessimistic outlook with respect to the farmer's own outlook in particular; third, the most probable price indicated was greater than or equal to the midpoint of the range of expected prices. (Four of the 43 could not formulate all of the measures necessary to be included in the statement. Had they been able to do so there might have been more than 10 in Column 3.)

[b] If the price were equal to or greater than the most probable price.

[c] At any level; rather take a chance.

[d] Other is composed of 4 beef, 2 corn, 1 potatoes and 1 soybeans.

A final factor, which was mentioned above, concerns the farmers' comprehension of the questions. If they did not in fact understand what was meant when interviewed, their answers would be of no significance to the theoretical point raised in this study. However, they seemed to have a very clear understanding of the questions. The interview was conducted quite informally, giving plenty of opportunity to explain clearly the meaning in each case, and there was consequently every reason to believe that they understood what was involved in the choices offered.

Not one farmer in the whole sample, however, reacted according to the

theory postulated. After examining the records and setting aside those whose attitude could be explained by other factors, ten (23 percent) remained who indicated that they preferred uncertainty to certainty as to the eventual price they would receive for their most important product. These results confirm for this sample what Brownlee and Gainer found in their Iowa study and what D. B. Williams found in Illinois.

It is not suggested that the above data constitute proof that farmers prefer uncertainty. Before accepting that thesis much more empirical work would be necessary. It does, however, indicate that there is a limit to how much certainty a farmer wants.

The degree of certainty desired probably depends upon the circumstances. If this is true, analysis that treats the farmer as a given factor, rather than part of the highly dynamic situation created by the uncertainty, is not likely to succeed in solving the mystery created by the very real but very difficult phenomenon of uncertainty.

IMPACT AND PROBLEMS IN ADMINISTRATION OF EXPORT PROGRAMS*

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ALMOST every attempt in the past three decades to solve the farm problem has led us inevitably into problems of foreign policy. The same is true at present. The battle cry is "sell more abroad." To whom? Answers of many policy makers to this question make illusory assumptions about foreign demand and supply and tend to misconstrue the nature of international trade. They also understimate the effect of these programs on our international relations. Many of the would-be answers are based on emotive phrases such as "starving millions," "inadequate diets," etc. Others have our allies scared and bewildered.

There is at present considerable discussion as to the nature and degree of recovery and restoration of trade among the free nations. There is also some question about the economic and political stability of a great many of these nations, as well as about their ability to contribute significantly to a program that has as duel objectives the prevention of further communists advances and the preservation of peace. There are several generalizations in this regard that may be given as information to be kept in mind as the analysis gets under way:

1. Free convertibility of exchanges is nearer than at any time since World War II, but is yet not imminent. The speed with which convertibility can now be attained is, in large part, a direct function of the international commercial and monetary policies of the United States and the magnitude of its foreign investment. To alleviate the world-wide dollar unbalance, i.e., the deficit situation of the non-dollar area *vis-a-vis* the United States in particular, and to achieve a respectable multilateral equilibrium, will still take considerable time.
2. The pattern, direction and terms of trade have changed considerably because of the war and because of present conditions. The constituency of trade has also been altered.
   a. Total and per capita agricultural and industrial outputs in the free world have risen to levels that are substantially above prewar. Also, the rate of increase in agricultural output in general has caught up with the rate of population growth.
   b. Increased labor and capital productivities in non-dollar areas, coupled with sensible monetary policies, offer the most positive approach to a favorable trade balance in the free world.
3. There has been a substantial decrease in agricultural exports by the

* Arizona Agricultural Experiment Station Technical Paper No. 350.

United States during the past several years. Vanishing export markets will be more difficult to regain and new ones harder to create in the absence of increased economic aid and military activity in foreign countries.

4. Under present circumstances, outright grants in the form of agricultural surpluses are, except in cases of extreme emergency, of questionable benefit to the economy of the recipient country.

This set of conditions—the agricultural surplus, the current military and political reality, and the definable eco-political relationships of the free nations—provides the setting in which the following analysis is cast.

Major Exports Acts

The basic acts related to export programs of the United States during the post-war period are as follows: (1) The Economic Cooperation Act of 1948; (2) The Mutual Security Program of 1951; (3) The Mutual Security Act of 1953, as amended by Section 550; (4) The Mutual Security Act of 1954; and (5) The Agricultural Trade Development and Assistance Act of 1954.

After World War II substantial quantities of agricultural commodities were disposed of under the UNRRA program and through government relief to occupied areas. However, post-war legislation relating to the disposal of agricultural surpluses was particularly embodied in the Economic Cooperation Act of 1948, which provided that, as a general rule, agricultural commodities in surplus in the United States should be purchased only in the United States, and which, in effect, authorized the Secretary of Agriculture to subsidize such purchases up to fifty per cent of the purchase price. While this Act did not require foreign countries to take U. S. surpluses, it provided that if a foreign country desired to program a commodity that was in surplus supply, it could purchase it with E.C.A. funds only in the United States. Naturally, this provision helped move surpluses. Prices that had to be paid for these surpluses were determined under several standards, depending upon whether the commodity was listed as surplus by the Secretary of Agriculture. Also, the Secretary for the first time was permitted to use Section 32 funds to subsidize purchases of such commodities made for export with Government-owned funds in an amount up to 50 per cent of the sales price.

When the Mutual Security Act of 1951 succeeded E.C.A. the surplus problem was not acute. This Act was amended in 1953 with mandatory provisions that agricultural surpluses, then accumulating rapidly in CCC coffers, must be purchased with a specified portion of the funds appropriated. Section 550 of the 1953 Act provided that not less than $100 million and not more than $250 million of the funds appropriated for MSA

purposes should be used to purchase surplus agricultural commodities. The Act authorized the President to enter into agreements for sale of such commodities and to accept as payment local currencies for the account of the United States. Disposition of surpluses under Section 550 was first thought of in terms of accomplishing dual objectives: (1) provide a means of disposal for a larger volume of surplus commodities than would otherwise be exported, and (2) to reduce the real cost of foreign aid to the United States. At the same time, the program was not conceived as "dumping," because commodities were to be *sold* for local currencies.

Under the Mutual Security Act of 1954 Congress directed that an additional amount not to exceed $350 million be earmarked from the funds available under that Act to dispose of surplus agricultural commodities in transactions involving payment with local currencies. However, the terms and conditions of these additional transfers were slightly different than those under Section 550—one of the major differences being that the quantities involved did not have to be in addition to usual imports from the United States.

In negotiating agreements the President is required to safeguard the substitution or displacement of usual marketings of the United States or friendly countries, to assure to the maximum extent practicable that sales are at prices consistent with maximum world market prices, to use private trade channels to the maximum extent possible, to give emphasis to underdeveloped and new markets, and to obtain assurances that such commodities will be used only for consumption in the country to which they are sold unless otherwise authorized by the United States.

The proceeds obtained from sales may be used for a number of purposes, including military assistance, purchase of goods or services, loans, grants, and for stockpiling materials, all either in the country to which sales were made or in third countries. The President is directed to take special precautions to safeguard against the displacement of foreign exchange earnings that would otherwise accrue to the United States or a friendly nation.

The Agricultural Trade Development and Assistance Act of 1954 contains similar provisions to those existing in the MSA legislation. One of the notable exceptions is the exclusion of any mention about guarding against the substitution or displacement of marketings of friendly countries. This new legislation emphasizes the use of surplus commodities for expanding markets in underdeveloped countries. It provides that not to exceed $700 million will be spent in developing foreign markets by June 30, 1957. These would be additional funds, and would neither be tied to nor dependent upon mutual security action. An additional $300 million is provided for emergency of famine relief programs abroad.

Impact of the Acts

What will be the impact of the recent attempts of surplus disposal (1) on farm surpluses, (2) on the economy of the recipient nations, and (3) on the foreign trade position of the United States?

Will such legislation as Section 550, the 1954 MSA provisions, and the Agricultural Trade Development and Assistance Act ameliorate the farm surplus problem to any substantial degree, in the immediate future, and under the circumstances assumed? This seems improbable. The Acts are too small and too retrictive to accomplish these ends.

Current legislation, which provides for expenditures of almost a billion and a half (1,350 million) dollars during the next three years, seems to offer little hope for substantial relief when considered in view of the amount of our domestic surplus, the rate at which the surplus is increasing, the types of commodities in surplus, and the rigidities in our farm legislation. The programs aimed at development of new and additional markets for agricultural products will do little in the short run to relieve the surplus situation, and in the longer run markets which are developed may be saturated with increased productivity from other countries.

The immediate effect of surplus disposal on the economy of foreign countries will reflect itself in the foreign exchange position of those countries. Long range effects will be felt through the terms of trade and the economic processes involved in capital formation. There is reasonable doubt that grants in the form of agricultural surpluses, the barter of surpluses for strategic materials, or the sale of surpluses for foreign exchange will appreciably remedy the basic exchange problems facing prospective recipient countries. Nor is it probable that surplus programs in their present form will produce a sizeable shift in the terms of trade in foreign countries, or result in an abnormal acceleration in capital formation in underdeveloped areas. In fact, the positive effects of such programs will be a minimum unless planned and executed properly.

The impact of surplus disposal on the foreign trade position of the United States is a complex matter and is quite debatable. This results to a great degree from the political ramifications of this and other aspects of our agricultural policies. There are few who expect surplus disposal programs to weaken our already strong trade position, but there are many who doubt the wisdom of strengthening that position to such level as to be able to "call all the shots" from the U.S.D.A. or the Congress of the United States. Therein lies the real danger, it is thought.

A central factor for consideration in the disposal of surpluses is whether or not aid in the form of surpluses comes in addition to the volume of aid that otherwise would be provided. In the 1953 MSA Act it was not *in addition to* but *in substitution for* $100 to $250 millions of MSA aid. The

1954 aid program raised this figure to $350 million with the same stipulation.

For a combination of the surplus disposal programs and the various aid programs to result in the disposal abroad of agricultural surpluses in an accelerated volume, it will be necessary that (1) the volume of aid provided be increased over what would otherwise have been provided (at least in particular countries if not in total) or (2) the aid programs be used to change the pattern of imports of countries receiving aid.

It is undoubtedly true that a higher level of investment or increased expenditure for technical assistance programs could be obtained in some underdeveloped countries if they were provided with a given level of dollar assistance and *in addition* were provided with surplus agricultural products. It may also be true that some countries would be willing to undertake a greater defense effort if they received a certain level of dollar assistance and *in addition* stipulated quantities of agricultural surpluses from the United States. Some countries might be willing to make additional end items available under an off-shore procurement program, under which additional procurement would be paid for with agricultural surpluses.

If surplus agricultural commodities are expected to substitute for dollar aid or other forms of assistance which otherwise would be received, then increased import of surplus agricultural products would mean decreased import of other commodities or a reduction in exchange reserves. Substitution of surplus commodities for a portion of an otherwise specified flow of dollars aid or other forms of assistance may deplete the exchange resources of the countries involved and result in decreased importation of such commodities or substitutes from still other (third) countries. It may result in a smaller importation of goods not required for investment or military purposes (a change in the pattern of imports). The inconvertibility of currencies presents obstacles to the realization of savings to the United States from such a program. Displacement of imports from other countries complicates our international relations because of the adverse effect on conditions of employment and balance-of-payments situations in those countries.

In order to currently alter the pattern of trade for the countries concerned in a manner that would substantially increase their importation of surplus commodities, a shift would have to be made from a more desirable to a less desirable use of the aid provided. This is assuming that the officials of the countries involved, including U. S. officials, know what they are now doing and know what they want in the realm of political and military objectives. Some sacrifice of objectives in our aid program would thus be involved in a substitution of surplus commodities for dol-

lars, and foreign countries would likewise be receiving less assistance in real terms. Surpluses would also be less effective than dollars in containing the inflationary implications of expanded defense and investment programs. Whether countries would undertake the same level of defense effort or investment under such circumstances would thus be open to question. It appears likely that countries would be willing to continue such levels only if the current or anticipated level of aid is higher than the minimum necessary to induce them to use resources for the purpose and in the quantities considered essential by the United States.

It is important to examine the use to which the local currencies generated by sale of surpluses are being put. Congress intended that they be spent so as to ultimately result in dollar savings to the United States. The monies have largely been used in Europe for off-shore procurement of military end items that we would have purchased in Europe for grant to European countries. Savings to the U. S. treasury have come largely in the form of costs of transportation and the savings on price of surplus commodities which would have been disposed of in some other fashion, including deterioration.

One particular non-military example of positive results of the program relates to the United Kingdom where the increased availability of fats and oils has permitted the elimination of rationing. This was apparently a sufficient compensation to the United Kingdom for the loss of some direct dollars generated by off-shore procurement. However, it would appear to be difficult to further utilize surplus commodities to add substantial increments to consumption, now that rationing has been suspended.

The problem of "safeguarding against the displacement of usual marketings" will not be so simple in the future, even when disposing of relatively small amounts of the surplus. It also suggests that it will be hard to avoid disturbing existing trade patterns, especially when the recipient countries sell, rather than donate, the commodities to their domestic users, as they will probably continue to do. If consumers spend more on these commodities, they will have less to spend on other items—unless their savings decline, or unless incomes increase simultaneously.[1]

In the administration of the Section 550 program to date it has proved difficult to arrange for sales that do not substitute for or displace usual marketings of the United States or friendly countries. Programs involving the sale of surplus commodities have been developed with 12 countries for a total of $245 million. Of this total, $208 million were financed from Mutual Defense Assistance Program funds and the remaining $37 million

[1] For details see Gerda Blau, "Disposal of Agricultural Surpluses," *Monthly Bulletin of Agricultural Economics and Statistics of the F.A.O.*, Vol. III, No. 5, May, 1954.

from funds appropriated for purposes of other sections of the Mutual Security Act.

The impact of this program on mutual defense is not as great as the figure of $208 million for use of Mutual Defense Assistance Program funds would seem to imply, since it is planned to use $81 million of the local currency sales proceeds for procurement of military items under the United States MDAP off-shore procurement program. Thus, the net impact of the 1953-54 Section 550 program in reducing the supply of ammunition and equipment to our allies under United States programs may be around $127 million. Moreover, a large part of the remaining sales proceeds, not used for off-shore procurement, will be used to increase indigenous defense efforts of allied countries and will further reduce the impact of Section 550 on military preparedness.

For the most part, the Section 550 program has been of a bilateral nature, concentrated on European countries that have been heavily involved in regional or commonwealth currency and trade arrangements. In analyzing the effects of the program on free-multilateral trade, one has to recognize the state trading entities, bilateral agreements, etc., that already exist. Section 550 and the 1954 MSA provisions *could* alter current trading patterns substantially unless administering forces adhere rigidly to the "no displacement" criterion, notwithstanding the fact that the amount of commodities distributed is only a small fraction of the United States farm surplus. But this effect would not necessarily be in the direction of making trade more free and multilateral. Indeed, there is no substantial evidence which leads one to believe that a more desirable state of trade was brought about by the Section 550 Program.

The conclusion above makes a distinction between grant aid, which is used to subsidize disposal of agricultural surpluses, and straight dollar aid because in the latter case there are no restrictions on the use of the funds as far as substitution of expenditures are concerned. For example, under the ECA arrangements, Western European countries would have been required to use their dollar aid to purchase wheat from the United States that they might have bought from Canada or Australia. If various governmental trading arrangements were assumed away—which would be quite an assumption under present circumstances—a different conclusion may be reached.

Problems in Administration and Convertibility

Adherents to the "sell more abroad" proposals have not been pleased with the results achieved under the various disposal schemes. For example, they claim that because the local currencies which accrued were used principally for military purposes and in countries with high living

standards, the concept behind Section 550 was emasculated. The original concept, they say, is more clearly set forth in the Agricultural Trade Development and Assistance Act of 1954, which places the principal emphasis on expanding markets in underdeveloped countries, but which also contains sections relative to use of surpluses for defense purposes and accelerating the drive for convertibility of currencies.

Advantages of Current Legislation

A case can be made for the use of surplus commodities in certain instances to obtain the local currency necessary to carry out an expanded investment program and to counter the inflationary aspects of such a program.[2] While there are many qualifications to such a program, a higher degree of expansion or development may be attained if *concurrently* with the sale of the surpluses, unemployed workers or underutilized farm and industrial labor are put to work on internal development projects that require little or no foreign capital. Initially, autonomous credit may be created by the importing government to facilitate the program. Most of the new wages paid out would undoubtedly go for food; and wheat and bread may constitute a large part of their purchases. (If the surplus products represent a wide selection of food and textiles, the entire worker's food expenditures may be balanced by the sale of the surplus foods and textiles.) A large portion of the expense of the program to the local government may be offset by the current sale of the surpluses, which are imported at no current cost to that government. Total food and fiber consumption will have been increased; and the increased domestic expenditures on development will have been made with little or no internal inflationary effect. This hypothesis rests on the fact that marginal propensities to consume some of the surplus products in underdeveloped areas run rather large. For example, a recent study in India relating to lower income families living in industrial cities during the period 1949 to 1951 shows that the marginal propensity to consume food was .51 and that of clothing was .09.[3]

The crucial condition that must be complied with by the local government in this program is that the additional wage expenditures on development direct and indirect, are made concurrently with the domestic sale of the surplus products, and in proper balance between the two. If this balance is not achieved the proper results will not be attained. The sale of surplus products, with no corresponding current action to expand consumers' income would divert expenditures from other products and so

[2] For details see *ibid.*

[3] Bepin Bahari, "The Changing Tendencies of Consumption in India," *The Indian Journal of Economics,* January 1954, p. 231.

compete with domestic or imported foodstuffs. On the other hand, expenditures of the funds procured by sale of surpluses in one period, in a later period, with no current addition to the supplies of consumers' goods available for consumption, would tend to create domestic inflationary pressures. While some slight improvements might be attained in better physical condition of the people, and their ability to work, the economic difficulties would be so great that only negligible progress would have been made toward increased food consumption, disposition of surpluses, or more rapid economic development.[4]

Even when they violate the "no displacement" principle, the advantages of the "capital via surpluses" programs may outweigh attendant disadvantages. The principal difficulty arises when too much is expected from such programs. Investment and capital accumulation in a poor country is bound to be slow. Income is the source of savings, and where per capita incomes are low, the annual rate of voluntary savings will also be low. In any event it is not clear that the export of surplus agricultural commodities in return for local currencies will expand markets greatly for United States agriculture. Neither is it clear how such a program will expand markets greatly for the importing countries.

In this vein, two examples may be given of what at the outset was called illusory attitudes of policy makers. The first deals with proposals to utilize a portion of the accrued soft currencies for advertising, promotional activities, etc., in backward countries. The idea seems to be if we can just do a good American "sell" job on these foreigners with respect to agricultural surpluses, our problem is over. The second example, akin to the first, relates to the various economic "missions" that were sent out ostensibly to "drum up" business to dispose of farm surpluses. As yet, there seems to have been no flood of orders in the offices of CCC. Markets for surpluses cannot be sought in the fashion that the Knight sought the Holy Grail. It is hard for one to believe that too much is expected of these super-sales and promotional activities.

Obstacle 1: Fundamental Inconvertibility: Soft Currencies

The sale of surplus commodities for soft-currencies, if made in a way which would avoid a direct or indirect dollar drain on the recipient countries, involves greater difficulties than proponents seem to realize. It has been proposed that the currency obtained from sales be used to make loans available to third countries so that markets may be developed. How the United States would make such loans or grants, and how this country would purchase materials with these funds without further complicating the trade process is not clear. How would the loans be repaid?

[4] Blau, *op. cit.* p. 14.

It has been pointed out[5] that unless the United States can use the inconvertible currencies for purchases that would not otherwise have been made with dollars, sales for inconvertible currencies will ultimately involve the same dollar drain on the countries importing the surpluses as would take place if they were sold for dollars in the first place. The use of currencies for loans to third countries will create a foreign exchange drain for the country whose currency is being loaned. In addition, it will require the borrowing country to assume a dollar obligation to repay a soft-currency loan, unless, of course, the loan is repayable in the same currency. In the latter event, the United States will still be left with the problem of utilizing the soft-currency proceeds in a manner that will not create an indirect dollar drain on the country to whom the original sale of the surplus was made. There seems to be no reason for supposing that demand for a country's exports will expand simply because the U. S. Government holds a larger volume of its currency. Free convertibility may not be quickened by such a policy, but may be delayed, especially insofar as these balances consist of currencies from the Sterling area.

The above analysis does not even consider some of the ill-effects that may come about as a result of the direct drain on a purchasing country's currency position. To the extent that monetary policy in a country is related to fiscal policy and employment, some critical results may be realized when large contractions in its money supply are made.

One general thesis is that more progress toward a real solution of the surplus problem can be accomplished per billion dollars through a direct approach to convertibility than through the prepetuation of subsidy or make-shift disposal programs. Because of the exchange position that has been attained in many countries they are now within reach of the goal. Total dollar and gold assets of foreign countries as of January, 1954, were $24 billions compared with $20½ billions at the end of 1952 and $8 billions in 1949. With a proper dollar stabilization fund they could attain convertibility and be in a position to expand trade in a truly multilateral sense. However, a solution to all trade problems should not be expected from a once-for-all type convertibility. Such an attitude as prevailed when Britain returned to the gold standard in 1925 could be disastrous to the free world. How much better to persuade governments to take the necessary measures first so that convertibility comes as the logical and advantageous conclusion of a policy that is not likely to be reversed.

Any approach to convertibility must take into particular consideration employment conditions in the United States, the problem of blocked sterling balances, and the regional arrangements among Western Euro-

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[5] Staff Papers presented to the Commission on Foreign Economic Policy, February, 1954, p. 172.

pean countries. Many possible methods suggest themselves:[6] a stabilization grant or loan by the United States; the use of much enlarged quotas under a revised and reunified International Monetary Fund; an all-round rise in the price of gold; the formation of some instrument in the United States such as a United States equalization fund, whereby, in cooperation with the British and other Exchange Equalization Funds, desirable, temporary support can be given to currencies that are under exceptionally heavy temporary pressure.

Obstacle 2: Administrative Difficulties

Another major obstacle to the implementation of the soft-currency sales program involves the proposed utilization of normal commercial channels and avoiding the displacement of commercial exports of friendly countries. Since ownership of a great volume of the surplus commodities is vested in a government agency (CCC) and the funds to be used to purchase them are government funds, and since the aid is to be provided on a government-to-government basis, it is necessary to establish rather complex procedures to provide for the transfer of funds to private hands and to insure their use for the purchase of CCC stocks. It is not clear as to how private traders will figure in the trading arrangements. Nor is it clear as to how the pricing arrangements would be policed if private traders had ultimate jurisdiction with respect to the transactions. Testimony related to the legislation leads one to believe that governmental agencies, namely, the Department of Agriculture and the Foreign Operations Administration, would be given almost complete responsibility for negotiating the necessary agreements relative to sale of surpluses and for delegating the responsibility for the use of foreign currencies that accrue.

Attempts to prevent the displacement of normal commercial exports from the United States poses an even greater obstacle. First, it is necessary to arrive at a judgment as to what otherwise would have been imported in a particular country, using either a base period approach or a comparison with otherwise planned level of imports, and then to induce the country to continue that level of imports while purchasing more of such commodities in return for payment in local currency. But if the country is already spending all it feels that it can afford for the importation of such commodities, the receipt of a larger volume from local currency purchase will create pressure to divert exchange from their commercial ("normal") procurement to the purchase of higher priority items. The tendency thus will be to substitute imports paid for in local currency for

[6] For elaboration on related subject matter see: J. E. Meade, "Bretton Woods, G.A.T.T. and the Balance of Payments—A Second Round?", *The Three Banks Review* No. 16, December 1952, p. 13.

normal commercial imports, particularly when purchases of commodities for local currency represents a substitution for expected dollar receipts. Testimony related to this part of the legislation espouses the belief that the prospects for adequate outlets for surpluses "lie in cutting across formal and informal trade preference areas established by other national groups. . . ."[7] This doesn't sound like precautionary talk designed to insure no disruption of the trade channels of friendly nations.

Still another problem in administration of the programs relates to timing. There still appears to be no method of temporal allocation relative to sales of surpluses, i.e., how much can be sold and when.

Obstacle 3: Conflict With Farm Programs

Many obstacles to surplus disposal will be generated by the fundamental conflict between the aims of the domestic price support programs and programs involving foreign aid and technical assistance. The assistance program is designed to meet deficiencies in resources required to support military and economic programs essential to United States objectives. The domestic agricultural program has as its purpose the maintenance of domestic farm income. The disposal of surplus commodities without interference in United States farm policy objectives, requires an expansion of demand for such commodities. By providing dollars to meet deficiencies in resources, the assistance program would, of course, provide for an increased demand for agricultural products. That result is incidental to its main purpose, however, and once certain minimal levels of consumption are met, its purpose would be to provide resources of the sort required for military and investment programs. At that point the purposes of the two programs diverge and tend to become mutually exclusive. Of course, if in any case the purpose of the assistance program changes and becomes related to provision of incentives or to other noneconomic ends, then the purposes of the two programs may not be quite so mutually exclusive and some expanded use of surplus commodities might be possible.

Obstacle 4: Impediments in U. S. Commercial Policy

The obstacles to a smooth working farm-surplus-for-local-currency program are buttressed by a sluggish United States commercial policy. Our tariff levels are still too high. They are more restrictive than the weighted average *ad valorem* equivalent would indicate, because the high duties are given a lighter weight than the heavier ones in computing averages. Tariffs are accompanied, moreover, by other measures that hamper and distort a multilateral flow of trade. Included among these are (1) obstruc-

[7] Riggle, J. J., Testimony before the House Agriculture Committee, April 28, 1954.

tive methods of customs administration, (2) the "Buy American" Act, (3) subsidies to the United States merchant shipping system, and (4) a reluctant attitude toward renewal of the Reciprocal Trade Act and toward enactment of a new tariff law.

The principle of disposal of surplus United States agricultural commodities for local currencies on a scale sufficient to contribute to solution of the surplus problem is also in conflict with the objective of establishing patterns of world trade and production that will make unnecessary the continuous provision of U.S. assistance. Many believe that the increasing dependence upon the United States and other parts of the dollar area for food and other agricultural products, which has been developing over a considerable period and which was greatly accelerated and intensified during and after the War, is a major factor in the creation of a dollar gap, inconvertibility of currencies, and widespread discriminatory trade practices. As has already been mentioned, the disposal programs are typically bilateral in operation and probably will do little to facilitate a multilateral system of trade.

While probably far from being a sufficient condition to the solution of these problems, the development of a pattern of world trade and production that will permit a greater proportion of requirements for food and agricultural commodities to be met from non-dollar sources is certainly a necessary condition for their solution. The sale of surplus United States commodities for local currencies would, however, interfere with the accomplishment of such an objective by establishing trade relationships and consumption habits that run directly counter to the pattern of trade required. Further, such a policy will clearly discourage investment and expansion of agricultural production in those areas in which expansion is required to permit the development of a pattern of trade that provides for a more economic allocation of resources and a decreasing dependence upon United States resources for support.

Conclusions

During the coming years of adjustment to changing patterns of trade, the most important actions for success will depend on the United States. Example and not retaliation must be the key to United States economic policy. The other free nations if they are to be treated as truly free and independent should not be asked, as a *quid pro quo* for tariff cuts or other trade adjustments, to alter their plans for industrialization, to abandon their welfare programs, to foreswear nationalization or to forsake economic planning. And, the United States must prepare sympathetically for a continued direct discrimination against dollar imports for several more years, though this discrimination promises to be much milder as of the moment.

Second, instead of being separately evolved and separately exposed to attack, both the agricultural and trade policies of the United States should be dealt with in the context of foreign economic policy as a whole. Proposals relative to price supports, subsidies, commercial policy, convertibility problems, grants, loans, military aid and international political decisions should be woven together as related parts of a common program. Insofar as they are related, these segments should be considered in the same hearings, covered in the same debates, enacted at the same time, included in the same appropriations and administered by the same agency.[8] If dealt with in this way, foreign commerce would become more multilateral as well as more free. Also, our objectives would become more clear and definable to ourselves and to our friends.

[8] Clair Wilcox, "Trade Policies for the Fifties," *American Economic Review,* Vol. XLIII, No. 2, May, 1952, p. 66.

NOTES

A FURTHER NOTE ON METHODS OF INCREASING DOMESTIC CONSUMPTION OF FARM PRODUCTS

WALTER W. WILCOX, in the August 1954 issue of *This Journal*, had an interesting note on "Methods on Increasing Domestic Consumption of Farm Products." Recognizing the conditions that are likely to give rise to an excess production of farm crops over consumption for the next few years, Mr. Wilcox indicated four points of an agricultural policy designed to increase domestic consumption of farm products by making the commercial production and marketing system work more effectively. The four points included special promotional campaigns to increase demand for those products having the most elastic demand; research and service programs to lower marketing costs and improve distribution facilities, especially for the products having the "more elastic demand"; production and marketing restrictions; and research programs to develop new industrial uses for farm products.

Excluded from the discussion were the possibilities of supplementary Government-financed distribution plans, and proposals for expansion of foreign markets or increased use of surpluses for foreign relief feeding. These are, admittedly, subjects for other notes or articles.

The major emphasis in the rest of the note was on shifting the emphasis of agricultural production towards more livestock and livestock products. Mr. Wilcox points to a rising trend from 1940 to 1953 in the per capita consumption of most livestock products and suggests a few activities whereby consumption levels might be further increased, including expansion of the school-lunch program, expansion of in-plant feeding programs by educational and service assistance, assistance to private firms in packaging and merchandising programs to place high-quality livestock products before consumers at lower prices, and expansion of educational programs featuring livestock products.

While one can hardly quarrel with these suggestions, perhaps something more could be said on "Methods of Increasing Domestic Consumption of Farm Products." The following is in the nature of an elaboration of some of the points contained in the note by Dr. Wilcox. This is made under three headings—utilization research, research programs designed to increase marketing efficiency and lower marketing costs, and research programs to increase demand for farm products in abundant supply.

Utilization research to develop new uses for farm products has been under way in the U. S. Department of Agriculture, the Land-Grant Colleges, and private organizations for some time. One can only concur that this type of activity should be enlarged, not only to develop new forms of

agricultural products to increase the market potential for them but also to modify farm products through physical and chemical means so as to recapture industrial markets where serious inroads are being made by raw materials of non-farm origin.

As outlined by G. E. Hilbert, Director of Utilization Research in the Agricultural Research Service, the objective of that agency, at this time is to find new products and uses to aid in the marketing of seasonal surpluses of perishable commodities and annual surpluses of stable commodities.[1] For perishable commodities, research is directed toward development of methods for converting them to permanently stable, palatable, convenient-to-use forms so that they are preserved and made available throughout the year. As examples, work is proceeding on frozen concentrated fruit juices, fruit and vegetable juice powders, dehydrofrozen and dehydrocanned fruits and vegetables, glucose-free dried eggs, and methods of converting whole milk and nonfat milk solids into stable, palatable forms for food uses. For surplus storable commodities research is designed to lead to greater consumption through discovery of improved methods of preventing staling in bread, greater use of corn in new fermentation methods for producing Vitamin B_{12} and antibiotics, an improved competitive position for cotton with respect to synthetic fibers through chemical treatment of cotton, and new industrial uses for fats and oils.

Research programs designed to increase marketing efficiency and lower marketing costs are still on a relatively small scale compared with activities in production research. Useful work is being done, nevertheless, and work along these lines undoubtedly should be expanded in view of prevailing rising trends in wage rates and in other marketing costs.

Preservation of quality of farm products once they have entered marketing channels is an important element in the over-all effort to reduce marketing costs. A substantial part of total marketing charges is attributable to physical losses and reductions in grade of products between the time they leave the farm and reach the consumer. Physiological and pathological changes occur in most products during periods of shipping and storage. Farm products are subject to insect infestation and to bruising all along the marketing line. Biological and entomological studies are as necessary in marketing research as they are in production research. Fundamental knowledge of physiological changes and of the organisms that attack farm products after harvest is a prerequisite in developing methods for controlling such changes and organisms.

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[1] "How Agricultural Research is Meeting the Challenge of Surpluses"—Talk before the National Chemurgic Council, Memphis, Tenn., April 6, 1954. (USDA Mimeograph.)

A closely associated field of work has to do with the invention of devices for rapid and reliable determination of quality factors. Quick determinations of moisture, oil content, and fat acidity through automatic devices and simple tests that can be used by country operators for checking the quality of grain and oilseeds, reliable means of measuring the nonfat solids in milk, and electric egg-candling devices that are much more rapid and that will give more information than hand methods, are proper subjects of marketing research. Improved methods of quality determination will aid in quality control and, perhaps of greater importance, will provide both buyers and sellers with more quality information more rapidly and more cheaply than the means now available.

Studies of market organization and structure, commodity by commodity, with assessment of the factors that affect costs through each stage of marketing, and by functions, are extremely useful if we are to understand how our agricultural marketing system works and how changes in certain factors affect it over time. Such studies are also useful in pointing out areas where improvements in the structure appear to be needed. Much of the research in agricultural marketing has gone into this field. The need and demand for it continues and probably will grow.

Another field of research aimed at reducing costs relates to the improvement of marketing facilities, methods, and practices. Research is showing that improvement in the physical facilities for assembling, storing, shipping, and receiving farm products, in handling methods including greater use of semi-automatic and automatic devices, and in physical operations in wholesale and retail establishments, can be tangibly measured in terms of dollars and cents savings in marketing costs.

In the recent reorganization of the U. S. Department of Agriculture the expansion of domestic markets through research was given emphasis by the establishment of a relatively new organization—the Market Development Branch—to devote its entire resources to this type of activity. Market development research takes the form of market tests of the commercial feasibility of new products and the determination of potentials for market expansion for new and established products whether by geographic areas, by income groups, or through institutional organizations including schools, mental and penal institutions, and homes for the handicapped and underprivileged. It takes the form also of merchandising studies to test out new methods of packaging, pricing, and displaying of farm products in retail stores. It includes the evaluation of the effects of new merchandising devices such as milk vending machines in increasing consumption. It may embody periodic reports and analyses of the flow of products into consumers' hands, as an aid to shippers and merchandisers in planning and conducting marketing and promotional programs.

Another aspect of market development research involves the determination of household and industrial consumers' attitudes, opinions, and preferences concerning agricultural products in the forms and qualities that they have when they reach the market place. Psychophysical tests may be made of consumers' taste preferences for such diverse things as orange and grapefruit juices varying in brix-acid ratio (sweet-sour), as bread of different specific volumes and containing different amounts of lard, sucrose, and nonfat milk solids, and as temperatures of milk by age groups. Attitude, opinion, and use surveys may be conducted relating to likes and dislikes for lamb and reasons therefor, preferences for pork cuts from lean versus fat hogs, and differences in preferences for beef of varying degrees of finish from grass-fed and grain-fed steers and heifers. Consumers' reactions to changes in can size for fruits and vegetables may be studied, as well as their habits and opinions regarding the use of peanuts and peanut products. Household and industrial surveys may be conducted to determine preferences and uses for cotton and wool in relation to synthetic fibers, including women's preferences for fibers in clothing and household textile items, men's preferences for fibers in suits and jackets, and uses and preferences for fibers in industrial outlets such as the automobile industry, the canvas and awning industry, the laundry industry, the cordage and twine industry, and the manufacture of insulated wire and cable. In the final analysis it is only the consumer, whether in the home or in industry, who can tell us what the product characteristics are that account for a declining or increasing trend in consumption and thereby provide the needed clues to producers and processors for modifying or standardizing products so as to improve their competitive position in the market.

But what, in the final analysis, does market development research add up to? Can total consumption of farm products be increased beyond the rate of population growth? In the last 15 years it has, but mainly in terms of expenditures for the more expensive foods and for more marketing services. In terms of quantity can changes resulting from market development research be significant in reducing our surpluses of agricultural products?

The answer to the last question is "yes," on two counts. First, we know that a significant proportion of the population, those in the lower income groups, is consuming less than normal amounts of agricultural products. Planned efforts to increase consumption in those groups, if successful, would result in an expansion in total consumption. During the 1930's such groups comprised, roughly, a third of the Nation. Today the proportion is lower. Nevertheless, an increase in consumption of around a fourth or a third in the lowest tenth of our population would largely wipe out our present agricultural "surpluses." Second, the effectiveness of research lead-

ing toward improved merchandising and promotional programs need not necessarily be measured in terms of total consumption of items of farm origin, but rather in terms of the kinds of food and non-food items consumed. Today there is an urgent need for bringing about certain consumption adjustments, with emphasis on increasing consumer demand for and sales of products in most abundant supply. Consumption adjustment is a necessary complement to the production adjustment programs upon which main reliance has been placed in the past two decades.

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JOURNAL OF FARM ECONOMICS CONTENT—A FURTHER COMMENT

THE recent article on the development and coverage of the *Journal of Farm Economics* during its first 35 years was an interesting and thought provoking one.[1] In a different way it presents the pattern of growth and change in our field of study. It also exposes one recent development which needs critical examination.

According to my classification and tabulation (which I, as Arnold and Barlowe, readily admit is clearly subjective) the following breakdown of major articles and notes (exclusive of proceedings) has appeared since 1950:

	Major Articles	*Notes*
	Percent	of Total
Policy and Government	18	7
Foreign Agriculture, trade, etc.	16	12
Farm Management, planning, production economics, etc.	15	16
Land Economics, credit, finance, water policy, etc.	14	9
Marketing, including cooperatives	11	21
Prices, demand, supply, etc.	6	7
General theory	3	4
Statistics, methodology, etc.	2	15
Miscellaneous and general	15	9
	100	100

Disregarding some possible classification errors, this breakdown of professional efforts deserves critical analysis. Though many members of our profession have become world travelers during the last few years, there is good reason to question the allotment of nearly one-sixth of our articles to their observations. No one will deny that the group spearheaded by

[1] Carl J. Arnold and Raleigh Barlowe, "Journal of Farm Economics—First 35 Years," *This Journal,* Volume XXXVI, August, 1954, p. 44.

Professor Heady has made great, thought provoking contributions to recent literature. Also, aspects of policy, government, land economics, etc. aways benefit from fresh views. However, these classifications have accounted for nearly three-fourths of the major articles and one-half of notes of the *Journal* since 1950.

And what of the rest of the field of agricultural economics? Particularly what of marketing and the broad field which it includes?[2] With the passage of the Research and Marketing Act, large additional sums of money have been funneled into that loosely defined area between "the producer and the consumer." This financial prod has resulted in a substantial expansion of professional men working in this area. And they have been working at something as anyone who watches the flood-tide of bulletins pouring out of the USDA and the colleges can testify. They have produced literally pounds of reports on consumer preferences, costs and margins, marketing channels, etc. In addition they are ranging wide into hitherto relatively unexplored corners of our economic system. Certainly the percentage of the *Journal's* articles covering this area and the related one of methodology is not representative of the work going on in this area.

What is wrong? Perhaps the answer lies in one or more of the following:

1. There are no methodological techniques or generalizations being developed? This is hard to believe. In the last three years there have appeared eight major articles and 18 notes on methodology alone in the *Journal of Marketing* (some by our own colleagues, but most by those outside the area of agricultural marketing).
2. Many of the workers in this field are relatively new in their positions. As such they are too busy meeting the promotion requirements of many institutions by routinely taking records and churning out station bulletins to think through and report the more fundamental aspects of their work.
3. There is a feeling that the *Journal* has become a private forum for a relatively few respected contributors.[3] As such it isn't worth the effort to break into the *Journal's* printed pages.

Certainly none of the above alone is the answer. But the direction that has been taken in recent years deserves serious consideration by all the members of the Association.

R. L. KOHLS

Purdue University

[2] The subject matter of the Proceedings issues have been purposely omitted. Here the program committee through its solicitation of papers obtains balance. As Arnold and Barlowe point out, a high portion of the contributions dealing with marketing were solicited. And, as those who attend the annual meetings know, the "roundtables" and "research reports" are indeed a poor substitute for a well developed article.

[3] Note the analysis of Arnold and Barlowe, *op. cit.* pp. 450-51.

SOME ADDITIONAL INFORMATION

THE *Journal* is one of the most important activities of the American Farm Economic Association. Its content is therefore of much interest to association members, as are the decisions which determine its content. Mr. Kohl's note suggested to me that readers cannot properly evaluate his comments on the contents of the *Journal* without knowing something of the material omitted.

The following table covers the period October 1951 to July 1954, i.e., the 1952-1954 calendar years of actual publication, and includes, of course, only the regular issues. The same classification titles are used so as to permit easy comparison with Kohl's table, although the time periods are not fully comparable. It was not feasible to separate notes and articles. This material is presented, not as a defense of an editor's decisions but rather as additional information by which the decisions of the editor and advice of the editorial council may be judged.

TABLE 1. CLASSIFICATION OF ARTICLES AND NOTES SUBMITTED BUT NOT USED IN THIS JOURNAL, 1952–54[a]

	Percent
Policy and Government	7
Foreign Agriculture, Trade, etc.	40
Farm Management, Planning, Production Economics, etc.	9
Land Economics, Credit, Water Policy, etc.	7
Marketing, including Cooperatives	9
Prices, Demand, Supply, etc.	4
General Theory	3
Statistics, Methodology	15
Miscellaneous and General	12

[a] Representing 89 manuscripts or 32 percent of those received.

It should be emphasized that not all these articles were rejected. Some were sent to other journals, some were withdrawn and replaced by other articles, a few were largely duplicates of articles being published, while others were withdrawn by the authors rather than to rework to take account of major or minor criticisms.

It is evident that articles not published were concentrated in the foreign agriculture and foreign trade area. In other subject matter fields, articles were widely distributed. No tabulation, of course, can reflect the nebulous concept of quality which is most important in an editorial decision.

During this three year period only three articles (one multiple authored) were solicited outside of the Proceedings issue, though the total was somewhat higher in the 1949-51 period. Thus the tabulations made by Kohls and myself largely represent the voluntary contributions of the profession. Readers in substantial agreement with Kohls' comments can draw only

one meaning: Additional contributions in the neglected areas must be written and submitted to the editor.

Finally I should like to take exception to Kohls' final point. In the Editor's Report (December 1954) reference is made to the number of different contributions in these three years in both the regular and Proceedings issues. The regular issues included 154 articles and notes from 137 different authors. Surely this does not indicate that the *Journal* is a "private forum for a relatively few respected contributors."

LAWRENCE WITT

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ERRATA

OUR article, "A Fertilizer Production Surface" (*This Journal,* Aug. 1954), contains certain typographical errors that were not caught in proof reading. The following corrections should be made: In the first equation on page 469, the exponent should be F_1. The order of the figures in columns 2 and 4 on page 479 should be reversed, with the smallest magnitude at the heading of these two columns. A negative sign should precede 5.682 in equation III on page 470. In equations 1 and 2 on page 473, the term should read $6.415P^{-.5}$. The term in equation (1) on page 481 should read $5.359P^{-.5}$. A minus sign should precede 5.7 in table 3.

EARL O. HEADY AND JOHN PESEK

Iowa State College

REVIEW NOTES ON THE HEADY-PESEK FERTILIZER PRODUCTION SURFACE

MESSRS. Heady and Pesek are to be congratulated upon the joint organization of an agronomic and economic research project reported in the August issue of *This Journal.*[1] The experiment they report is unusual in that the field experimentation was planned to fulfill the requirements of analysis amenable to economic interpretation.

As an exercise in methodology this report perhaps is to be highly regarded. The authors, however, advocate the general use of this methodology whereas the experimental evidence they give in its support may tend to discourage rather than encourage its use. The experiment may be exceptional in this regard but until additional evidence is developed in support of the method proposed we believe that advocating general use is premature.

[1] Earl O. Heady and John Pesek, "A Fertilizer Production Surface," *This Journal* Vol. XXXVI, No. 3, Aug. 1954, pp. 466-482.

The empirical results reported are of trivial economic importance. For example, if the teatment "optimum" for price situation "A" (table 7, p. 482) were used instead of the treatments "optimum" for price situations "B," "C" and "E," the loss in revenue net of fertilizer cost would be only \$2.67, \$2.35, and \$4.03 per acre respectively.[2] These price situations represent extreme fluctuations. If historical prices for the period 1951 through 1954 are used instead of the extremes presented in table 7, the differences are even more modest. The estimated gross income less fertilizer cost would be increased by 39 cents, 67 cents, and 83 cents per acre under 1952, 1953, and 1954 price conditions, respectively, if the "optimum" treatment for each year was used instead of the "optimum" treatment for the price situation in 1951.[3] These amounts are only 0.2 percent, 0.5 percent, and 0.6 percent of the estimated gross income less fertilizer cost for these years.

Moreover, the authors make the point that ratios of nutrients should change as well as total amounts of fertilizer with relative price changes. However, if fertilizer nutrients were applied at the "optimum" total amount for the price situation of 1951, 1952, 1953, and 1954, but in a ratio of 1:1 instead of the "optimum" ratio for the price situation of those years, estimated gross income would be depressed by 33 cents, 11 cents, 18 cents, and 30 cents per acre, respectively.

This methodology also appears to be wasteful of agronomic research efforts in that substantially the same practical recommendations could have been derived from fewer observations. They use a total of 114 field plots in the experiment whereas the results obtained with 34 of these plots would yield substantially the same results. Suppose only the 34 plots represented by the middle row and the middle column of table 1 had been used. To the yields of these plots, curves substantially the same as those indicated by the unbroken lines in figures 2 and 3 (page 474)

[2] There is an inconsistency between the price situation "D" and the indicated optimum usage of nitrogen and phosphate. Thus, situation "D" could not be considered.

[3] April prices as given for Iowa in *Agricultural Prices* were used. The price of N per pound was derived from the price of ammonium nitrate. The price of P_2O_5 per pound was derived from the price of concentrated superphosphate. From the following list it is apparent that there is considerable year to year variation even in these prices:

	1951	*1952*	*1953*	*1954*
Corn, bushel	\$1.58	\$1.60	\$1.38	\$1.41
N per pound in ammonium nitrate	.13	.14	.14	.15
P_2O_5 per pound in concentrated superphosphate	.09	.09	.09	.09

Equation No. III "Quadratic square root" was used in all the comparisons made in this note, after the sign of the first term in this equation was changed from positive to negative. This change was found to be necessary in order to duplicate the results presented in table 7.

could have been fitted.[4] From such curves the "optimum" rate of each input could be chosen, given the level of the other inputs. The "optimum" chosen in this manner would result in gross income less fertilizer cost that would be within 25 cents per acre of the "optimum" based upon the function fitted to all observations for the prices that prevailed during 1951 through 1954.[5] This seems to be a rather small return for the 80 additional plots used in fitting the two variable function. These small differences would scarcely be sufficient to encourage research workers to conduct the larger experiment, especially in light of the frequent difficulty of getting even 34 plots of such homogeneity of soil as to keep the variance within workable bounds.

As stated previously these comments are not made in criticism of the methodology. Even though it was demonstrated above that the proposed methodology was not proven to be superior to a much simpler alternative and even though such proof is needed before the methodology should be recommended for general use, the data presented were not sufficient to permit specific criticism of the method itself. The data that were presented however do suggest the need for serious consideration of the ultimate practicability of the method to general research efforts in this area. In order for this method to be superior to the alternative considered above, there must exist important interaction effects between the nutrients at rates of application that are relevant to the interest served by the research. If such interest is the establishment of a basis for practical farm recommendations, then it can be said that the data reported in this article did not indicate that these interactions were important. Whether the evidence developed in this experiment is unusual in this respect is a question that can only be resolved by further empirical investigation. Until it is resolved, acceptance of the method for general use should be held in abeyance.

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[4]Unfortunately not enough data were presented to permit the independent fitting of a curve to these treatments. The curve referred to in the text appears adequate for the present discussion. It departs somewhat from apparent best fit at high fertilizer rates but this segment of the curve is not relevant to this particular discussion.

The usefulness of the article would have been enhanced, and incidentally, its criticism facilitated, had the plot yields been substituted for the barren "X"s of table 1.

[5]The actual differences by years were: 1951–24 cents; 1952–22 cents; 1953–5 cents; and 1954–6 cents.

[*]At the time this report was prepared the authors were respectively an agricultural economist and an agronomist of the staff of the Tennessee Valley Authority. Their interest in this matter stems from research work conducted by the Authority in the field of economics of fertilizer production and use.

FARM TECHNOLOGICAL ADVANCE AND TOTAL POPULATION GROWTH

IN RESPONSE to various requests, this note revises and brings up-to-date the central table in the article, "Farm Technological Advance and Total Population Growth," which appeared in the August 1945 issue of this *Journal*. I am indebted to John C. Ellickson of the Agricultural Research Service for appraisal of the conceptual differences underlying the various indexes available for the revisions.

As now revised, all the series in the table may be brought up-to-date at any future time, or placed on an annual basis back to 1911, by use of currently available sources without adjustment.

TABLE 1. CHANGE IN FARM EMPLOYMENT, PRODUCTION, OUTPUT PER WORKER, AND TOTAL POPULATION, 1870–1953
(1870=100 for all indexes)

Year	Farm employment			Farm output		Output per worker		Total population		
	Number (million)[1]	Index	Percent change[2]	Index[3]	Percent change[2]	Index	Percent change[2]	Number (million)[4]	Index	Percent change[2]
1870	8.01	100	—	100	—	100	—	39.9	100	—
1880	10.04	125	25	152	52	122	22	50.3	126	26
1890	11.62	145	16	190	25	131	7	63.1	158	25
1900	12.76	159	10	243	28	153	17	76.1	191	21
1910	13.56	169	6	266	9	157	3	92.4	232	21
1920	13.43	168	− 1	296	11	176	12	106.5	267	15
1930	12.50	156	− 7	336	14	215	22	123.1	309	16
1940	10.98	137	−12	372	11	272	27	132.1	331	7
1950	9.34	117	−15	454	22	388	43	151.7	380	15
1953	8.58	107	− 8	480	6	441	14	160.0	401	5

[1] From 1870 to 1900 as reported in U. S. Bureau of the Census, Population series P-9, No. 11; from 1910 to 1953 as reported in "Farm Labor," Agricultural Marketing Service, U. S. Department of Agriculture, Jan. 13, 1954. The first series is adjusted to the annual average level of the second series in 1910.

[2] For 10-year period. (1953 figure represents change in only 3 years).

[3] Three-year averages centered on year indicated. For 1870 to 1911 derived from the ideal index computed by Frederick Strauss and Louis H. Bean, Technical Bulletin No. 703, "Gross Farm Income and Indexes of Farm Production and Prices in the United States, 1869–1937," table 61, page 126. For 1919 to 1953 derived from "Changes in Farm Production and Efficiency," Production Economics Research Branch, Agricultural Research Service, U. S. Department of Agriculture, Washington 25, D. C., June 1954, table 1, page 10. These two series were linked on the years 1910–1914.

[4] U. S. Bureau of the Census, "Historical Statistics of the U. S." for 1870 to 1939, "Current Population Reports" P-25, No. 71 for 1940 to 1950 and P-25, No. 102 for 1951 to date. This whole series is also available in "Changes in Farm Production and Efficiency" cited above.

Since the paper was originally written, a new index of farm output was developed and published by the Bureau of Agricultural Economics and is being maintained currently by the Production Economics Research Branch, Agricultural Research Service, U. S. Department of Agriculture. By including an adjustment for inventory changes, this index differs from the USDA index of the volume of agricultural marketings and consumption in the farm home. As a consequence, the revised table also uses the corresponding index from Bean and Strauss for the years 1869 to 1911. Again, the Agricultural Marketing Service (formerly BAE) series on farm employment has recently been revised and improved. Because this series can be used as published without adjustment, it was substituted in the revised table for the Census series on farm employment.

Finally, in some years since 1940, a substantial number of U. S. citizens have been overseas with the armed forces and their food and fiber needs were supplied primarily from our domestic farm production. Accordingly, they have been included in total population in the revised table. The population totals are standardized as of July 1 for each year shown and contain an upward adjustment for under enumeration in 1870.

These revisions in nowise affect the argument of the paper as written in 1945. Up to 1940, the overall relationships in the rate of change in farm employment, production, output per worker and total population have not been affected by these minor revisions. Futhermore, since that time, farm technological advance, as reflected in output per worker, has continued to outrace total population growth even more rapidly than in the two preceding decades, despite the fact that the rate of population increase accelerated substantially after 1940.

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COLIN CLARK ON THE FUTURE OF U. S. AGRICULTURE

MOST readers of this *Journal* are familiar with the fact that Professor Colin Clark, now Director of the Agricultural Economics Research Institute of the University of Oxford, England, has for some time been predicting a shortage of farm products in the very near future even in North America and a consequent sharp rise in their prices. His latest and most available statement on this subject is in an article in the August, 1954, *Review of Economics and Statistics* called "Afterthoughts on Paley," which is intended as a review of the Paley Commission report, whose official title was *A Report to the President by the President's Materials Policy Commission,* of June, 1952. Professor Clark's specific statement is that the farm surpluses of the U. S. will disappear after a few years and that by 1975 this country will be importing almost exactly half of the farm products it consumes!

My own conclusions in the statement which I prepared for the Paley Commission were that the demand for farm products in the U.S. in 1975 would be about 40 percent larger than in 1950, and that an increase of 85 percent in farm output over 1950 was "technically possible and economically feasible"—"assuming that demand would keep pace with output," but that an increase of only a third per acre was all that could be expected on the basis of the average rate of gain in technology in 1925 to 1950. I pointed out, however, that the rate of gain in the 1939-1949 decade was more than double this rate, and given a growth in demand such as

occurred in that decade there is little reason to doubt that output will increase as fast as in the 1940's.

I also pointed out that a large acreage of open pasture land could be improved, much of it brought into crop-and-pasture rotations, whenever needed, and that considerable woodland once farmed could be returned to crop rotations at a cost per acre far below that of reclamation of arid land by irrigation.

As for the foreign trade balance, I expected imports of farm products to increase a little faster than demand for farm products in general because with rising incomes consumers tend to diversify their purchases more. But I also saw reason to believe that exports of farm products would increase a little as trade relations became more normal. All of these projections, including Professor Clark's, of course assumed no intervening wars of large magnitude.

The part of my projection which Professor Clark considers most "wildly mistaken" is that which relates to the size of the labor force in agriculture in 1975. I projected that it would decline by ten percent, the same total amount as in the decade of the 1940's. Professor Clark says that by 1975 only 2,000,000 workers will be left on the farms of the U.S.! And although the productivity per man-hour will increase at a rate four times the rate of the 1900-1940 years, we shall still be producing only $24.5 billions worth of farm products in 1975, and the domestic requirement of farm products will be $48.3 billions in that year, both measured in 1950 prices.

The reader does not need to be told that this is a highly important matter, nor that the ideas of the man who wrote the two editions of "The Conditions of Economic Progress" (1940 and 1951) are ordinarily not to be taken lightly. If Professor Clark is right, the struggle over surpluses in this country is much more than a waste of energy, it is misdirecting the thinking of our whole population. All readers of this Journal will want to read Clark's "Afterthoughts on Paley" in *The Review of Economics and Statistics* and the trenchant reply by Harvard's Dean Edward S. Mason, who was a member of the Paley Commission. His review covers other major points on which Clark differs with the findings of the Commission, notably on fuel consumption and requirements, water supply and utilization, and future sources of forest products. The divergences are fully as wide on the first of these as with respect to the supply and consumption of farm products. The purpose of this note is only to prepare the way for the reading of Clark's article and Dean Mason's reply.

As Dean Mason points out, the largest single factor in the difference in the projections is the population increases assumed. The Paley Commission took the middle of the latest then available Census Bureau projections, namely, 193.5 million in 1975. This has since been raised to 209.5.

But Clark uses 234 million as his 1975 population projection. The Census Bureau's highest projection is 221 million. The Paley Commission's projected increase in annual disposable real income is from $1300 to $2000 per capita, or 54 percent or 2.2 per year. The income elasticity which I used in my estimating was 0.2. Clark accepts this same elasticity figure, but multiplies it into a 2.5 percent increase in "real income" per year. (One cannot be sure that he is using disposable income as we calculate it in this country.) The figure which he comes out with is a 74 percent increase in aggregate demand for farm products by 1975, or almost 3 percent per year (perhaps the 2¼ percent that he mentions in his text but compounded). Combining my 54 percent increase in per-capita income with a 0.2 income elasticity and a population increase from 152 million in 1950 to 209.5 million in 1975, or 38 percent instead of the 28 percent in the Paley Commission assumption, gives an aggregate increase in demand of about 50 percent compared with Clark's 74 percent, and the 40 percent of the Paley Commission projection.[1] This seems to be a much more rational pre-estimate of the 1975 demand for farm products in the U.S. than Clark's 74 percent. The reader need scarcely be reminded that we had already accumulated a surplus production of 8 percent over domestic consumption and exports in 1953, and that this has been reduced very little in 1954 in spite of large drought areas. This is in line with what Koffsky concluded in his paper cited earlier.

What will seem to most citizens of this country as the wildest part of Clark's projection is, of course, that of a farm labor force in 1975 of only 2 million. This would call for a very great and rapid consolidation of our farms, of which there is only small indication as yet, plus a vast substitution of machinery and power for labor. In support of his projection, Clark cites the large decline in the farm labor force in the 15 years following 1938, and a chart in which the decline in the farm labor force from 1950 to 1953 is projected straight ahead down to his 2 million mark in 1975. If he will just project the straight line to somewhere between 1985 and 1990 we shall appear to have a farm labor force of zero and import all our farm products instead of half of them as in his 1975. Thirty odd years and we will have no farming at all, our land all growing up to weeds and trees.

As for the decline after 1938, we in this country realize that as a result of the continuing urban unemployment of the 1930's a few million workers

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[1] Dr. Nathan Koffsky in his paper on "The Long-Term Price Outlook and The Impact on American Agriculture" at the 1954 American Farm Economics Association meeting makes a pre-estimate of only a 45-percent increase, partly on the basis of a declining income elasticity as incomes reach higher levels.

had been kept from moving into non-farm jobs, and that the over-full employment of the war years, plus military service, drained them rapidly from the farms in the war years. Many returned to farms in 1946, but more did not, and others joined these presently, especially with the onset of the Korean War. The decline in the farm labor force from 1950 to 1953 averaged 2.7 percent a year. The year 1954 so far shows about the same rate of decline as in the three years preceding.

Professor Clark could make a stronger case if he would use total farm population instead of farm labor force. As of April 1st of each year, the U.S. farm population had declined from 16.6 percent of the total population in 1950 to 13.5 percent in 1954. Project this rate straight ahead and down and we shall have very little agriculture well before 1985-90.

The real question is when the leveling out in the decline will begin, and at what rate it will take place. The position which the farm economists of this country will nearly all take will be that production will start to expand again just as soon as demand catches up with supply, except for a possible lag of a year or two, or a spell of poor crop weather, and that it will keep up with growing demand except for a few products (like wool) in which not much of our land area has comparative advantage. They will expect the farm labor force to continue to decline, but at a slackened rate once production starts expanding again. It will decline partly because of more mechanization, partly because of higher yields, and partly because of consolidation or closing out of farms especially in the South. There will be more concern that this last does not proceed fast enough than over the contrary of this. The decline of 717,000 in the number of farms between 1940 and 1950 was due in large measure to a change in census procedure, but partly to decline of farming on border-line farms, and to actual consolidation, much of this latter taking the form of renting additional land. There may well be a decline of another half million farms by 1960 or 1965, but this will mostly be of very small farms. The land area in crops and pasture may very well be larger. I am prepared to admit that my projection of only a 10 percent decline in the farm labor force by 1975 was a bit too cautious, as Dean Mason suggests.

It is apparently Professor Clark's idea that the causal sequence in such adjustments is that urban industry and trade will outbid agriculture for workers, and this will force mechanization. If some of us had lived under Australia's labor government as long as he did, we might reason in the same way. The prevailing conception in this country is that the causal relation runs both ways, that farm labor is *pushed* out in about as many situations as it is *pulled* out, and that commonly both forces are operating together. Probably Professor Clark does not realize that except in our South the real incomes of workers on commercial family size and

larger farms in this country have, since 1945, compared favorably with those of urban workers.

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JAPAN NEEDS U. S. SURPLUS FOOD

OF ALL industrial groups in the United States the American farmer stands to benefit most by trade with Japan. In 1953, imports for food cost the Japanese $560 millions. Wheat imports alone amounted to over 46,000,000 bushels last year. That was almost twice the amount of rice imported, and rice is the nation's staple food crop. Only 24 million bushels of rice were imported in 1953. Many American farmers would be surprised to learn that Japan *could* take considerably more than that much wheat in the years to come, possibly a third of the annual amount slated for export for the next few years.

The change from rice to wheat imports reflects the effort to get more food for less cost. Rice imports cost more than $200 a metric ton in 1953: wheat imports cost less than half that much. In the past Japan has had a trade deficit and U. S. procurements for military purposes have made the difference. The new Mutual Security Pact will partially compensate for loss of a U. S. market for war purposes since the Korean was is stopped. The real income for purchase of food over the long pull must come, however, from markets for Japan's factory products, for Japan must continue to industrialize and export the products of manufacturing if she is to survive.

All political parties in Japan are agreed on the need for more imports of wheat. That is something very unusual, for you do not get agreement very frequently from the left wing Socialists on the one hand and the Liberals or the Progressives on the other. A resolution was passed jointly by all of the parties in the Lower House last December calling for a change in the people's eating habits. Passage in the Lower House is usually followed by passage in the Upper Chamber, too. These parties not only resolved to slash the amount of rice imported, and to purchase more wheat from abroad, but they urged the cutting of the rice ration, for rice is still rationed in Japan. They also urged the use of wheat as a staple food and the increased use of dairy and fishery products. You can contrast this Agreement on a food program with the sharp differences between them, for example, on MSA aid. About the only provision on which there has been a semblance of agreement between the leftist and the major political parties like the Liberals, is the allocation of $50 million for the purchase of wheat.

There is some hope that Japan will soon be able to meet all of her food needs from domestic production. Normally the Japanese farmers produce about 80 per cent of the nation's food needs. Most of the land is used for rice production. Even that is a small area compared with the crop area in the United States. Japan's total area of land is only a little larger than that of California, and only six percent of this land area is now used for crops. Those who hope for food self-sufficiency point out that 8 per cent of the land is good grass land, much of it in forest, which, like the rolling hills of the South in the United States, could be terraced and contoured and used for grain and cattle.

Those on the more pessimistic side point out that this is beyond the typical Japanese farmer. He is really a garden farmer, tending his few acres by hand with the utmost care. Because of his intensive methods he raises more rice per acre than is raised anywhere else in the world, except in spotted areas in Spain and Italy.

In any case, Japan will need to buy food from abroad for many years to come. Her very rapid population growth will insure that need. The increase is more than a million a year (in 1953 it was 1,800,000), so that in 1953 Japan had 87 million, more than half the population of the United States.

The American farmer needs to know, too, that gradually the Japanese people are learning to eat more wheat. The change is slow, for the Japanese love rice. They eat it for breakfast, dinner and supper, and use it for many festival occasions. The average consumption is about five bushels per person per year. That takes about 435 million bushels, but the farmers normally produce only 330 million bushels, and in 1953 their production dropped to 275 million. So they need to import at least 160 million bushels of some kind of grain, and more and more of it will be wheat, if the government's resolution means anything.

Efforts are being made by the government and other agencies, including Christian missions in rural areas, to increase the use of wheat and other grains and to produce more milk and meat. Few babies in Japan are fed milk, as there is no milk available. Beginning this year, the government is shipping in 500 head of Jerseys for the grassland areas. Many of these slopes are good for grass and grain, but the forest service is reluctant to see it used that way. Too much of the greatly needed forest land in Japan was cut for war time needs. Now the young growth on these slopes is jealously guarded by government agents. Much of this land, moreover, was not affected by the land reform and belongs to the big land owner who sees, in a few years, a good profit in timber production.

The need for milk in the Japanese diet was shown by a study carried on by the International Christian University Rural Welfare Research In-

stitute in a farming village. Only two or three of the 130 families included in the study had milk in their diet. Only four cows could be found in the entire village. In addition to the government efforts to get cows into the hands of farmers, rural mission centers are bringing them in.

Production of cereals other than rice and of animals will increase only slowly. Food imports in huge quantities will continue to be needed for many years to come. Wheat imports will doubtless gain on rice imports, and the American farmer has a stake in this market. But he has a greater stake in the kind of a country Japan turns out to be, politically. The Japanese have had a taste of freedom. They want to remain free and they know that to remain free they must increase their trade with the free nations of the world.

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Director of the Rural Welfare Research Institute,
International Christian University,
on leave from the University of Illinois, 1953-56.

ESTIMATING CATTLE ON FEED

PERIODICAL data relative to cattle on feed for finishing in the United States have been based in the past largely upon annual estimates. Only in three Corn Belt states,[1] California, and Idaho, have more frequent reports been provided. However, beginning January 1, 1955, quarterly surveys will be made in six additional Corn Belt states,[2] Arizona, Colorado, and Texas.

Because of an evolution in the seasonal pattern of cattle finishing operations in a number of states, data collected once annually are no longer adequate. Two or three decades ago, when cattle finishing was largely a winter operation with one filling of the feedlot, estimates provided once annually as of January 1 included most of the cattle fed out during the entire year. Such data were effective for comparing the relative importance of cattle feeding among states and for relating the number of cattle reported on feed to other factors. But during recent years, primarily in the far west, cattle finishing has developed into a year-around process and an important percentage of feedlot cattle are not in feedlots at the time of the January 1 estimates.

An approximation of the total number of cattle finished annually can be derived from information obtained by quarterly surveys of cattle on feed in those states mentioned above. This can be done by adding the number of cattle reported to have been on feed less than 90 days as of

[1] Illinois, Iowa, and Nebraska.
[2] Ohio, Indiana, Minnesota, Missouri, South Dakota, and Kansas.

each quarterly survey date to the number of "short fed" cattle reported to have been placed on feed and marketed between quarterly survey dates. The number of "short fed" cattle can be determined by adding the marketings during the previous quarter to the number of cattle reported on feed as of the survey date and subtracting both the number of cattle which had been on feed less than 90 days as of the survey date and the number of cattle on feed as of the date of the previous quarterly survey. To illustrate this, data have been extracted from the quarterly reports of cattle on feed in California for January, 1953, through January, 1954, and are summarized in table 1. In this illustration, the number of cattle reported to have been on feed less than 90 days as of the first of April, July, and October, 1953, and January, 1954, plus the number of "short feds" is equal to the number of cattle placed on feed during the 1953 calendar year; the total number being 1,057,000 head.

The need for quarterly reports for making comparisons among states and for determining the aggregate number of cattle fed out in the United States is strikingly evident in California, where much of the feeding is on a year-around basis. As of January 1, 1953, 327,000 head of cattle were reported on feed in California; 1,274,000 in Iowa; 731,000 in Nebraska; and 600,000 in Illinois.[3] In California, where year-around feeding is predominant, the January 1, 1953 inventory represented only 33.4 percent of the total number of cattle marketed out of feed lots in that state during the 1953 calendar year. But for the combined data of the states of Iowa, Nebraska, and Illinois, the January 1, 1953, inventory represented 73.2 percent of the cattle marketed during the same calendar year. California with 327,000 head of cattle on feed as of January 1, 1953, actually marketed an estimated 1,034,000 head out of feedlots during 1953, with an average feedlot turnover of 3.16. The total number of cattle marketed out of feedlots for each of the other three states was 1,163,000 for Iowa; 1,026,000 for Nebraska; and 869,000 for Illinois. The turnover, based on annual marketings in relation to the January 1 inventory, was 1.31 for Iowa; 1.40 for Nebraska; and 1.45 for Illinois.

Thus California, although ranking far below each of the three major cattle feeding states in the Corn Belt on the basis of the January 1 inventory, ranked second in total number of finished cattle marketed during the year. The high feedlot turnover in California is, as implied, associated with a considerably shorter length of time in the feedlot than is true in the Corn Belt. On the average, cattle placed in feedlots in California have had more growth before entering the feedlots than is true in the Corn Belt. Total feedlot gain in pounds in relation to the aggregate January 1 inventory weight in California would not show as high a turnover in relation to

[3] Taken from quarterly reports of cattle on feed for the respective states, State-Federal Crop and Livestock Reporting Service, January, 1953, through January, 1954.

TABLE 1. NUMBER OF CATTLE PLACED ON FEED ANNUALLY AS DETERMINED FROM QUARTERLY REPORTS OF NUMBER OF CATTLE ON FEED, MARKETINGS, AND LENGTH OF TIME ON FEED AS OF QUARTERLY SURVEY DATES, CALIFORNIA, JANUARY, 1953, THROUGH JANUARY, 1954[a]

Item	Quarterly Reports				
	January 1, 1953	April 1, 1953	July 1, 1953	October 1, 1953	January 1, 1954
		Thousands of Head			
Number of Cattle on Feed as of Survey Date	327	211	333	307	350
Marketings During[b] Previous Quarter	—	277	180	300	277
Number of Cattle on Feed Less than 90 Days as of Survey Date	239	121	267	231	276
Number of "short fed" Cattle Marketed and Sold During Previous Quarter	—	40[c]	35	43	44
Total Number of Cattle Placed on Feed During Previous Quarter	—	161	302	274	320

Total Number of Cattle Placed on Feed During 1953 Calendar Year = 1,057,000
Total Number of Cattle Marketed During 1953 Calendar Year = 1,034,000

[a] Taken from Quarterly Reports of Cattle on Feed, California Crop and Livestock Reporting Service, California Department of Agriculture and USDA Agricultural Marketing Service, January, 1953, through January, 1954.
[b] Taken from The Livestock and Meat Situation, USDA Agricultural Marketing Service, August 25, 1954, page 17.
[c] Marketings during previous quarter (277) plus number of cattle on feed as of survey date (211) minus number of cattle which had been on feed less than 90 days (121) and minus number of cattle on feed as of the previous quarterly survey date (327).

the Corn Belt states as is true in the case of numbers of cattle.

At least one important source of bias is apparent in determining total number of cattle placed on feed and total number of fed cattle marketed annually from quarterly estimates. This is memory bias in reporting the length of time cattle have been on feed as of the quarterly estimate and the actual number of cattle marketed between quarterly survey dates.[4] Such bias could be largely eliminated through the use of monthly estimates. The additional cost of the more frequent reports may well be justified on the basis of greater accuracy and simplicity.

Effective estimating of cattle on feed cannot be realized until standardized reports including estimates of annual turnover are provided in all states.

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[4] As determined by the writer in interviewing cattle feeders in California, Idaho, Arizona, and Nevada, as part of a regional project entitled "The Function of Finishing Operations in the Marketing of Western Cattle" to be released soon. The study also includes Utah, Montana, Wyoming, Colorado, and New Mexico.

THE PROPER PLACE OF THE "BIGNESS" ARGUMENT IN AGRICULTURAL ECONOMICS

A NUMBER of important papers on the subject of "bigness" have been delivered at professional meetings within the past year or two. Most of them have completely missed the point as far as the fundamental issues in American agricultural policy are concerned. The main conclusion of this beside-the-point argument is that America is a "workably competitive" economy. Statistical proof is presented to show that competition, the "workable" variety, is increasing in America rather than decreasing. The works of such pioneers as Berle and Means,[1] and Burns,[2] are considered to be refuted by proof of a considerable degree of price and non-price competition in many areas.

The annual meeting of the American Economic Association in 1953 was devoted in great part to testimonials that "we now see American big business for what it is." Economists had at last discovered that modern business, although not competitive in the classical sense, was obviously not wreaking on society the dire consequences that traditional theory warned would inevitably result from any degree of monopoly. The business press in America is understandably delighted with the fact that professional economists are at last seeing the light. *Time* magazine hailed the A.E.A. meeting as a demonstration that economists are at long last losing their senseless fear of "responsible" big business, and recognizing it for a beneficent and creative force. *Fortune* had not waited for the economic meetings. In an article in June, 1952, entitled "The New Competition," that publication had stated editorially:

> The American economy has delivered to people the benefits that perfect competition was calculated to give. Therefore, it does not hold that business, to bring maximum benefit to consumers, must necessarily consist of many small sellers competing by price alone. . . . And in terms of such a concept [workable competition], the businessman who talks sincerely of our competitive way of life is right.

The point, the one which too many of our professional colleagues persist in missing, is that bigness *does* bring more benefits than pure competition would have brought, but not the same ones! One of the major benefits of the classical system was complete freedom from the danger that anyone could exercise economic power. Atomistic competition led to another important benefit—the best possible equity situation would be obtained from the use of available resources. These two benefits would

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[1] Adolf A. Berle, Jr., and Gardiner C. Means, *The Modern Corporation and Private Property* (New York: The Macmillan Company, 1933).

[2] Arthur R. Burns, *The Decline of Competition* (New York: McGraw-Hill Book Company, Inc., 1936).

be achieved only in the absence of social planning or action. In fact, any such social planning or action would be wasteful.

A few of the economists presently writing about the benefits of the "new type of competition" in America, "workable competition," or whatever it is called, understand this point. But most apparently do not. The business press, particularly, is happy to conclude that inasmuch as modern competition brings us *more* benefits than the pure type, we can trust business to operate without social direction even more implicitly than we trusted the theoretical competitive variety. The *reductio ad absurdam* of this line of argument would be the use of social power to crush little business, so that America could achieve the benefits of modern bigness in many additional lines. (Indeed, some wartime procurement policies, allocation policies, and tax policies of the government may have done just that.)

The facts are, of course, that our system of "workable competition" has allowed us to achieve some wonderfully beneficial results in a technical and material sense. We would not willingly do away with it by enforcing perfect competition; we would thereby exchange our tremendous array of gadgets for an undoubtedly more austere life. At the same time, the modified competition of American business giants obviously does not have the built-in ability to serve as the sole regulatory force for our society, a force which will guarantee that we will never feel the weight of individual power, or a force which will guarantee that society's ideas of equity and justice will always be fulfilled. Whether modified competition of modern America can be permitted to serve even as the *major* regulatory force or not is a question that cannot be decided through the generalizations of economic theory. Each case must be decided, when society agrees that the case is becoming important, on its own merits, in a political manner.

What is the importance of all this to agricultural policy? Those who see in workable competition a sufficient regulatory force in the American economy are ordinarily those who look with considerable disfavor upon the increase in social control and regulation of economic activity that has occurred during the past twenty-two years. They persistently urge a "return" to a hands-off role for government more consistent with the laissez-faire philosophy. To a laissez-faire economist, one of the most horrendous examples of social interference has been the agricultural price-support program. Such an economist recalls that proponents of price-supports have often justified the program on the grounds that it was necessary *only* to counteract monopoly positions elsewhere in the economy. The laissez-faire economist is gratified to discover, in quantitative terms, that there is a great amount of something called "competi-

tion" in America, and that it is in fact not declining at all. He thus has found an argument in favor of "returning" to "free enterprise" and driving from office the social planners, whether New Deal or Ike-Benson Republican.

It has long since ceased to be fruitful for economists to dally over this useless argument. Social action and control are an integral part of our social and economic complex, and have always been, and will always be, as long as we maintain our technological civilization. It is enlightening to discuss in economic terms the more fortunate features of business bigness. It is quite true that many economists remained far too long blind to them, simply because bigness did not fit into their neat theory-skeleton. It is equal blindness to leap to the opposite conclusion, that the discovery of "goodness" in large-scale business and research organizations makes unnecessary the continual study of possibilities of danger that are present in any situation where some humans can control the destinies of other humans.

Finally, it is difficult to see why economists continue to waste time on the generalized argument either that the American economy is so monopoly-ridden that balancing monopoly must be set up, or so workably competitive that social intervention is unnecessary. Society will continue, as it has in the past, to consider specific problems as they become pressing, and intercede when it believes intercession necessary.

If a social scientist could so free himself from bias with regard to these two useless arguments as to render a relatively neutral judgment, he would probably agree that social intercession in the agricultural sector during the last two decades has been both temperate and moderately successful.

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HOW CERTAIN FACTORS AFFECT THE ECONOMICS OF SOIL CONSERVATION

ECONOMIC returns from conservation farming are difficult to calculate in simple terms because many factors are involved. Some of the most important ones are, (1) soil type, (2) period of time considered, (3) the number and nature of conservation measures applied, (4) type of farming, and (5) efficiency of forage consuming animals.

In a recent Ohio study the budgetary approach has been used to evaluate the economics of conservation farming on Muskingum and associated soils. This analytical method has certain advantages over others that have been commonly used. It permits holding constant all factors except the ones being studied. Therefore, differences in income can be calculated

for farm situations that differ only in the amount of conservation practices applied.

In this study net income from a group of soil depleting practices was compared between two groups of conserving practices. These comparisons were made for three different farm situations, (1) a dairy farm with two different levels of milk production, (2) a beef cattle farm, and (3) a crop farm with no livestock.

Receipts, expenses and net income were calculated from data obtained from a 1952 survey of 55 farms in the eastern part of the State. These data included land use, fertility practices, livestock numbers and production. Some of the farmers interviewed were following soil depleting practices while others used conserving ones.

All of the 55 farms had Muskingum and associated soils. These soils cover about one-half of southeastern Ohio. They erode easily because many slopes range from 10-30 percent. Usually these soils are acid except where liberal amounts of lime have been recently applied.

Many combinations of practices result in soil depletion, but only one was considered in this study. The combination selected included no mechanical erosion control practices, red clover and timothy meadows, little or inadequate amounts of lime and fertilizer on the cropland and no permanent pasture improvement. This combination included the major depleting practices found on the farms surveyed. The use of these practices was called "soil depleting farming" for purposes of identification.

Two groups of soil conserving practices were studied. Both were recommended by the local soil conservation district whose goal was to reduce average annual soil losses to less than three tons per acre and maintain soil productivity at a high level. These two groups of practices represented the extremes from the standpoint of corn and meadows recommended for Muskingum soils.

One group of conservation practices included contour strip cropping, alfalfa-grass meadows, and liberal applications of lime and fertilizer on the cropland and permanent pasture. This group of practices was referred to as "conservation farming with corn".

The other group of conservation practices included no contour strip cropping, no corn, alfalfa-grass meadows and liberal applications of lime and fertilizer on the cropland and permanent pasture. For identification purposes, this group of practices was called "conservation farming without corn". Conservation farming on other soils might include combinations of practices quite different from the ones used in this study.

Calculations were made for a typical size farm of 120 acres. By using contour strip cropping no reduction was needed in the acreage of grain crops for "conservation farming with corn." Prices used were averages for the period 1943-52.

TABLE 1. CROP PRODUCTION DATA USED IN CALCULATING NET INCOME FOR SOIL DEPLETING AND CONSERVING FARMING

	"Soil Depleting Farming"	"Conservation Farming"	
		"With Corn"	"Without Corn"
Corn, Acres	12	12	0
Wheat Acres	14	14	15
Meadow, Acres	34	34	45
Permanent Pasture, Acres	36	36	36
Woods & Misc. Acres	24	24	24
Total Farm Area, Acres	120	120	120
Corn, Bu. Per Acre	46	68	—
Wheat, Bu. Per Acre	22	26	26
Meadow, Tons Per Acre	1.2	2.5	2.5

Net income figures in Table 2 show how profits from conservation farming depend upon the conservation measures applied, type of livestock and efficiency of forage consuming animals.

When all forage was fed to cows producing 5,000 pounds of milk for sale "conservation farming with corn" gave $897 more labor income than "soil depleting farming," but required 998 hours of additional labor and $2,400 more capital.

When all forage was fed to cows producing 5,000 pounds of milk "conservation farming without corn" gave $244 more labor income than "soil depleting farming" but required 946 hours of additional labor and $2,500 more capital.

TABLE 2. NET INCOME FROM SOIL DEPLETING AND CONSERVING FARMING WHEN CROPS WERE USED DIFFERENT WAYS

Source of Income	"Soil Depleting Farming"	"Conservation Farming"	
		"With Corn"	"Without Corn"
Forage fed to 5000 lb. dairy cows	$1,661	$2,558	$1,905
Forage fed to 9000 lb. dairy cows	2,813	4,083	3,833
Forage fed to beef cattle	893	1,315	482
All crops sold	506	1,711	1,057

When all forage was fed to cows producing 9,000 pounds of milk "conservation farming with corn" gave $1,270 more labor income than "soil depleting farming," but required 840 hours of additional labor and $2,500 more capital.

When all forage was fed to cows producing 9,000 pounds of milk "conservation farming without corn" gave $1,020 more labor income than "soil depleting farming," but required 842 hours of additional labor and $2,800 more capital. Livestock numbers with high producing cows were less

than with low producing cows because of heavier feeding per animal.

When forage was fed to beef cattle "conservation farming with corn" gave $422 more labor income than "soil depleting farming," but required 391 hours of additional labor and $1,750 more capital.

When forage was fed to beef cattle "conservation farming without corn" gave $411 less labor income than "soil depleting farming." This decrease resulted even after using 66 hours of additional labor and $2,000 more capital.

When all crops were sold "conservation farming with corn" gave $1,205 more labor income than "soil depleting farming," but required 263 hours of additional labor. Capital needs remained unchanged.

When all crops were sold "conservation farming without corn" gave $551 more labor income than "soil depleting farming" but required 22 hours of additional labor and $500 less capital.

This study showed two ways that conservation farming could increase net income. One was by increasing the rate of return in labor and capital. The other was by providing more hours of work and greater use of capital.

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SOLVING MINIMUM-COST FEED MIX PROBLEMS

IN AN article appearing in this Journal dealing with the application of linear programming to the problem of feed mixing the authors state: "For problems having many requirements, and for realistic cases when several prices vary together, other devices for obtaining the solution in a reasonably short period of time will probably have to be developed."[1] The purpose of this note is to indicate that such a "device" may be the electronic computer. Whether the feed mixing application of linear programming (either by desk calculator or by electronic computer) represents an economical substitute for less systematic methods is, of course, a question to be answered ultimately by the feed manufacturers themselves. We hope, however, to give some indication of the time required to solve certain mixing problems by electronic computation.

We illustrate the use of linear programming with an electronic computer[2] by presenting the results to the problem of mixing a minimum-cost hog feed to meet the following requirements:

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[1] Fisher, Walter D. and Schruben, Leonard W. "Linear Programming Applied to Feed Mixing Under Different Price Conditions." *This Journal*, November 1953, p. 483. See also the basic article: Waugh, F. V. "The Minimum-Cost Dairy Feed." *This Journal*, August 1951, pp. 299-310.

[2] University of Illinois computer (Illiac).

Level of nutrients desired	*Not less than*
Protein	35 percent
Fat	1.5 percent
Calcium	3 percent
Phosphorus	1.25 percent
Vitamin A or carotene	20,000 units per lb.
Riboflavin	7 Mgms per lb.
Niacin	48 Mgms per lb.
Pantothenic acid	12 Mgms Per lb.
Choline	1,400 Mgms per lb.
Vitamin B_{12}	.025 Mgms per lb.
Salt	1.5 percent
Iodine	.00014 percent
Manganese	80 P.P.M.
Antibiotic	.025 Gms per lb.
Vitamin D_2	900 units per lb.

In addition the fiber content must not exceed 10 percent.

The ingredient analyses and prices are set forth in Table 1. The minimum cost solutions for four situations are presented in Table 2. About ten minutes were required to prepare the basic input tape (in this case for the problem of mixing a ton of 35-percent protein feed under Price Situation A)[3] for use by the electronic computer and slightly less than ten minutes of machine time were required for each solution. Slight changes (e.g., prices or requirements) may be made in the basic input tape in a few minutes and the problem rerun to obtain the revised solution.

Although the present capacity of the Illiac is such that a problem of this size (17 requirements and 20 sources) can be handled,[4] it is important to note that several of the requirements can each be met from only one source. (Vitamin D_2, manganese, antibiotic, salt, and iodine.) Thus the amounts and costs of these may be readily calculated by hand prior to selecting the minimum-cost quantities of the other ingredients by linear programming. In the present case the problem may be reduced to one of 12 requirements with 15 sources.

Several interesting problems may be readily investigated. We shall consider only three variations from the basic problem of mixing a ton of 35-percent protein feed under Price Situation A. First, it may be of interest to determine the amount of bulk in the minimum-cost mix, as well as the ingredient cost of meeting the bulk requirement. "Bulk" refers to the number of pounds in a ton of feed in excess of that necessary to meet

[3] Actual prices of ingredients to an Illinois feed mixer in May 1954.

[4] The present computer capacity is given by the relation $4(i + j + l) + ij = 712$, where i = number of requirements and j = number of sources (structural vectors).

TABLE 1. ANALYSIS AND PRICES OF INGREDIENTS

Ingredient	Price situation		Percent protein	Percent fat	Percent fiber	Percent calcium	Percent phosphorus	Mgms. per pound				
	A	B						Riboflavin	Niacin	Pantothenic acid	Choline	Vitamin B_{12}
	(dollars per ton)											
*Alfalfa meal	66.00	50.00	17.0	2.0	25.0	1.50	0.20	7.00	14	14.0	400	0.00
Distillers solubles	92.00	60.00	25.0	5.0	3.0	0.40	1.50	6.00	50	10.0	2,000	0.00
Fish meal	156.00	140.00	60.0	7.0	1.0	5.00	3.20	2.00	25	4.0	1,400	0.15
Fish solubles	140.00	120.00	32.0	3.0	0.0	0.10	0.80	6.00	120	18.0	1,000	0.25
Meat and bone scraps	128.00	112.00	50.0	9.0	2.5	10.00	5.00	2.50	21	2.0	750	0.10
Molasses	30.00	25.00	3.0	0.0	0.0	0.50	0.05	1.00	20	17.0	300	0.00
Dried skimmilk	200.00	150.00	34.0	0.5	0.0	1.30	1.00	9.00	5	15.0	500	0.00
Soybean meal	96.00	100.00	45.0	0.5	6.5	0.20	0.65	1.30	9	5.5	1,200	0.00
Dried whey	116.00	100.00	12.0	0.5	0.0	0.80	0.70	12.00	5	20.0	700	0.00
Riboflavin supplement	1,280.00	1,000.00	1 gram riboflavin per ounce									
Niacin	9,000.00	8,000.00	pure niacin									
Calcium pantothenate (feed grade)	3,840.00	3,000.00	2 grams pantothenic acid per ounce									
Potassium iodide mixture	4,000.00	4,000.00	8.8 percent iodine									
Salt	30.50	30.50	pure salt									
Irradiated yeast	960.00	960.00	16,000,000 units D_2 per pound									
Manganese sulphate (65 percent)	96.00	96.00	23 percent elemental manganese									
Choline chloride (25 percent grade)	340.00	300.00	21.5 percent choline									
Vitamin B_{12} supplement	480.00	400.00	6 gms. B_{12} per pound									
Antibiotic supplement	1,200.00	1,200.00	5 gms. antibiotic per pound									
Vitamin A oil	850.00	800.00	8,000 units vitamin A per gm.									

* Also contains 80,000 units carotene per pound.

TABLE 2. MINIMUM-COST MIXES

Ingredients	Price Situation A: With bulk requirement 35 percent protein	Price Situation A: Without bulk requirement 35 percent protein[a]	Price Situation A: With bulk requirement 40 percent protein	Price Situation B: With bulk requirement 35 percent protein
Alfalfa meal	500.000	0.000	365.461	500.000
Distillers solubles	0.000	0.000	0.000	314.693
Meat and bone scraps	516.130	598.218	543.108	511.164
Molasses	146.035	0.000	0.000	0.000
Soybean oil meal	783.452	890.869	1,036.261	623.876
Riboflavin supplement	0.503	0.709	0.546	0.408
Niacin	0.150	0.166	0.155	0.125
Calcium pantothenate	0.287	0.559	0.378	0.294
Irradiated yeast	0.113	0.113	0.113	0.113
Manganese sulfate	0.696	0.696	0.696	0.696
Chlorine chloride	12.602	13.149	10.284	8.599
Antibiotic supplement	10.000	10.000	10.000	10.000
Vitamin A oil	0.000	11.023	2.966	0.000
Vitamin B_{12} supplement	0.000	0.000	0.000	0.000
Salt	30.000	30.000	30.000	30.000
Potassium iodide mixture	0.032	0.032	0.032	0.032
Total weight (pounds)	2,000.000	1,555.534	2,000.000	2,000.000
Cost (dollars)	99.63	96.85	107.95	90.80

[a] Quantities of all requirements are the same as those for making a ton of 35 percent protein feed with the exception of weight.

all other requirements. Using Price Situation A the problem is first solved with the requirement of making exactly one ton of feed (first column of Table 2), and then solved without that requirement (second column of Table 2). Although considerable change takes place in the quantities of ingredients, the cost decreases only \$2.78 per ton. The amount of bulk appears substantial (approximately 450 pounds) and this may have implications with respect to feed-handling costs.

The manufacturer may also wish to know the cost of changing, say, the protein requirement from 35 to 40 percent. The appropriate comparison is made between least-cost mixes. By comparing the results presented in Table 2 (Column 1 and Column 3) we see that the ingredient cost of increasing the protein requirement five percent or 100 pounds is \$8.32. This is less than the cost per 100 pounds of protein from its cheapest source, soybean oil meal (\$10.67 per 100 pounds of protein). The quantities of the two ingredients (molasses and alfalfa meal) whose primary role is apparently one of furnishing bulk, are reduced as we change to a 40-percent ration. Although these ingredients also furnish protein they are a more expensive source of this nutrient than soybean oil meal and meat and bone scraps. Thus the increased cost of changing to a 40-percent

feed is slightly less than the cost of 100 pounds of protein from its cheapest source. In this connection it is also interesting to note that the following overfulfillment of requirements occurs with both mixes (per ton basis):

	35 percent	*40 percent*
Vitamin B_{12}	1.613 mgms.	4.310 mgms.
Phosphorus	6.972 pounds	9.622 pounds
Fat	30.369 pounds	31.370 pounds
Fibre	11.172 pounds	27.700 pounds

Minimum levels of the first three nutrients are exceeded by the amounts indicated, while fibre comes within 11.172 pounds (35-percent feed) and and 27.700 pounds (40-percent feed) of reaching its allowable maximum (200 pounds per ton). Since the surpluses of vitamin B_{12}, phosphorus, and fat are greater in the 40-percent feed mix than in the 35-percent mix, and the "shortage" of fibre is also greater in this mix, the saving that accrues due to the replacement of approximately 135 pounds of alfalfa meal and all of the molasses apparently more than offsets any cost that might be associated with the increased quantities by which these four requirements are overfulfilled.

Finally, nonproportional price changes in the ingredients will usually result in a different least-cost mix. The results for a second set of prices (Price Situation B in Table 1) are presented in the last column of Table 2. Price Situation A represents the prices of ingredients experienced by an Illinois feed mixer in May 1954. Price Situation B is a hypothetical case slightly altered from Situation A. The major sources of protein retain the same rank with respect to cost per pound of protein in Situation B as in Situation A. Soybean oil meal is the cheapest source per pound of protein under both situations; meat and bone scraps represent the next least expensive source of protein, etc. These two ingredients comprise the major portion of each least-cost mix (1,299.582 pounds under Price Situation A and 1,135.040 pounds under Price Situation B). However, as we move from Price Situation A to Price Situation B distillers solubles replaces all of the molasses and a portion of soybean oil meal and the meat and bone scraps. Yet if cost per pound of protein were to be the criterion for selection, distillers solubles is cheaper than molasses and more expensive than soybean oil meal and meat and bone scraps under both price situations. In this example the choice of a protein source solely on the basis of cost per pound of protein would not have resulted in the least-cost mix.

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COMMENTS ON "ECONOMIC NATURE OF THE COOPERATIVE ASSOCIATION"

IN THE February, 1953 issue of *This Journal*, Richard Phillips presented a very important article on the theory of the economic nature of the cooperative association.[1] Using the pioneering writings of Frank Robotka and Ivan V. Emelianoff as stepping stones, Philips has formally developed the conditions necessary for profit maximization in the cooperating firms.

I shall here point out an important modification in the conditions necessary for profit maximization in the cooperating firms vertically integrated with the joint plant. Following Phillips, the conditions for a *single* vertically integrated firm are: "The vertically integrated firm determines this optimum output by equating the sum of the marginal cost functions in all plants with the marginal revenue in the final plant from which the product is marketed."[2] Phillips refers here to Werner Zvi Hirsch who deals with some special cases.[3]

Concerning cooperative associations, Phillips stresses the autonomy and sovereignty of the individual member firms as regards their individual plant or plants and correctly points out that the member units, not the joint plant, are the maximizing units. He employs, however, the same general conditions for profit maximization for the cooperating firms vertically integrated with the joint plant as for a single vertically integrated firm.

He states: "The cooperating firm equates the sum of the marginal cost in its individual plant or plants and the marginal cost in the joint plant with the marginal revenue facing the firm in the market where the product is sold.[4]

Both Phillips' text and his example show clearly that he means that the marginal cost a member firm faces in the joint plant is "the relevant segment of the marginal cost function in the joint plant" and that the marginal revenue a member firm faces in case of a marketing cooperation association is "the relevant range of the marginal revenue curve in the joint plant." At this point, Phillips' analysis is in error.

The correct statement (based upon Phillips' own model and which makes it consistent) is that *the marginal cost a member firm faces in the joint plant is the average cost in the joint plant and the marginal return a participating firm faces in a marketing cooperative association is the*

[1] Phillips, Richard, "Economic Nature of the Cooperative Association." *This Journal*, Vol. 35, No. 1, February, 1953, pp. 79-87.

[2] Phillips, *Ibid.*, p. 79.

[3] Hirsch, W. Z., "The Economics of Integration in Agricultural Marketing." Unpublished Ph.D. thesis. University of California Library, Berkeley, 1950.

[4] Phillips, *Op. cit.*, pp. 79-80.

average return in the joint plant. Therefore, under the assumption of profit maximization, a participating firm in a marketing cooperative association equates the sum of the marginal cost in its individual plant or plants, plus the average cost in the joint plant with the average revenue facing the joint plant in the market where the product is sold.

This statement follows from the operation principles stated by Phillips, and commonly adopted in agricultural cooperative associations, and from the fact that they are associations of autonomous and sovereign economic units. The "net return" the farm firms in a marketing cooperative receive (after patronage refund adjustments to secure services at cost) is usually the difference between the average revenue for the total output of the joint plant and the average cost for the total output. And since they act as independent firms, they act according to the final "net return" they receive through their participation in the joint plant.

A great deal of theoretical and practical significance lies in the fact that marginal cost and revenue functions facing the individual participating firms are actually the corresponding joint plant average cost and revenue functions. For example, in Norway, before World War II, the increase in the milk production went mainly into butter which the farmers claimed gave an unsatisfactory net price to the producers (less than the production cost). However, the production of milk increased steadily. One of the important reasons for this was that practically all milk producers were organized in eight regional federated top cooperative associations (milk pools) which used price discrimination keeping the price of fluid milk and of milk for production of cheese higher than the price of milk for production of butter.[5]

The individual producers in each region did not face the milk pool's marginal revenue of the increase of production. The marginal revenue each faced was the relevant segment of the milk pool's average revenue function. They were aware of the milk pool's marginal revenue (the revenue of milk for production of butter) because it was widely publicized in journals and newspapers. However, they did not act according to the marginal revenue in spite of the fact that they did know it. The explanation is that they did not face it. They faced the blend price which was the marginal revenue for the farmers.

Phillips has made an outstanding contribution through his analysis of the formal conditions for profit maximization in the cooperating firms. There is, however, an error in Phillips' approach, namely that a formal analysis of the conditions for an optimum also can give basis for conclusions about appropriate institutional arrangements. Phillips writes as

[5] See Norby, John C. and Oddvar Aresvik "Cooperative Milk Marketing in Norway," *This Journal,* Vol. 33, No. 3, August, 1951, pp. 320-335.

if it were possible to base conclusions about appropriate institutional arrangements for the cooperative associations almost exclusively on analysis of the formal conditions for production equilibrium. His analysis represents an intermingling of the formal and institutional analysis. Conclusions about institutional arrangements seem to be derived from the formal analysis and supported by it, although, in fact, his formal analysis is mostly irrelevant to the institutional problems of the cooperative associations. Conclusions about appropriate institutional arrangements cannot be based exclusively on analysis of the formal conditions for an optimum. There are as a rule alternative institutional arrangements that judged solely on a formal level would enable the formal conditions for an optimum to be attained, or in practice a reasonable approximation to the economic optimum. Furthermore, the institutional arrangements adopted in cooperative associations have very important non-economic implications. Therefore, it is necessary not only to make a choice between alternative institutional arrangements, but also to introduce *additional criteria* in making the choice, and these criteria will represent *value premises*. Conclusions about the appropriate institutional arrangements are, by logical necessity, inferences from value premises as well as from factual premises.

No institutional arrangement for the cooperative associations can be expected to operate perfectly in practice. The most that can be expected is a reasonable approximation to the economic optimum. The arrangements must therefore be judged in part (1) by the practical administrative problems entailed in so operating them as to approximate the economic optimum, and (2) by their non-economic implications. The cooperative associations from a part of the social structure within which their members live and they have some fundamental social and ethical implications.

These ethical implications raise the whole question of the relevant place of value premises in an analysis of the cooperative associations. Value premises also may enter into an analysis as *hidden* valuations and will then hinder inferences from becoming truly objective. It is very important therefore to work with *explicit* value premises.

The value premises cannot be found by logical deduction. They cannot be a priori self-evident or generally valid. They can have only a hypothetical character. The principle of selection of the alternative sets of hypothetical value premises should be their relevance, determined by the principles and ideals adopted by cooperative associations in practice. It is not a task for an economist to tell what value premises the members of the cooperative associations shall adopt. The set of value premises chosen must not include mutually incompatible ones but must be consistent. Sometimes in practice one finds a balance or a compromise in the

set of value premises of cooperative associations. It may be a type of substitutional relationship between some of the principles. Some of the value premises will be more inclusive than others and subsume others under them. Some value premises stand in a proximate relationship to others (as means to ends).

The selection of the necessary value premises for an analysis of the appropriate institutional arrangements for cooperative associations approaching the principles above stated must lead to a choice of the so-called cooperative principles as we find them adopted in practice.

Our conclusions above can be illustrated by looking at the rule of voting in cooperative associations. According to Phillips the rule for "proportional voting" in cooperative associations follows logically from pure economic analysis of cooperation based on the economic structure of the associations without value premises involved. Taking the true nature of the group decision-making process into consideration it is easy to see that his analysis is in error at this point. Making group decisions in the group of cooperating persons is, from a formal standpoint, exactly the same problem as making social choices based on individual orderings, which is intensively discussed in the literature of welfare economics. Today, I think it is the consensus among the economists that it is impossible without value premises to make the step from individual orderings (preferences) to group orderings. As Arrow stresses:

> There can be no doubt that, even if interpersonal comparison is assumed, a value judgment is implied in any given way of making social choices based on individual utilities, so much Bergson has shown clearly. But, given these basic value judgments as to the mode of aggregating individual desires, the economist should investigate those mechanisms for social choice which satisfy the value judgments and should check their consequences.[6]

Voting is a method of amalgamating the preferences of individuals of a group in the making of group decisions. Value premises are therefore implied in any given way of voting in cooperative associations. The rule "proportional voting" is partly based upon value premises as well as on the rule "one person-one vote." The "scientific basis" is therefore the same for both rules. They are based upon different value premises.

Phillips' conclusion regarding the rule of voting and his remarks in his final paragraph about cooperative principles can cause great confusion and doubt also about the validity of his formal analysis. I hope my comments above, which are related to Keynes' distinction among a positive science concerning what is, a normative science concerning what ought to be, and an art concerning systems of rules for the attainment of

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[6] Arrow, K. L., *Social Choice and Individual Values,* New York: John Wiley & Sons, Inc., 1951, pp. 4-5.

a given end[7] will help to avoid that. Phillips' formal analysis does *not* reveal the cooperative principles as "inaccurate or irrelevant," and his statement about some of the principles therefore does not reveal a weakness of his theory as indicated by Savage.[8]

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[7] Keynes, J. N., "*The Scope and Method of Political Economy*," Reprinted, London, 1930, pp. 34-35.
[8] Savage, J. K., "Comment on 'Economic Nature of the Cooperative Association,'" *This Journal*, Vol. 36, No. 3, August, 1954, pp. 529-534.

REJOINDER TO LONG'S REPLY ON THE VALUE QUESTION

IN HIS reply to my note entitled "The Value Question"[1] Erven Long succeeded in clarifying "some of the sources of disagreement" between us. This rejoinder is written, not for the purpose of having the last word in an argument, but rather to further sharpen the issues. For this purpose it probably is best to consider Long's reply point by point.

1. His first point deals with the definition of freedom. I criticised a sentence of his which I interpreted to be his definition of freedom. Long replied that his entire article was "an attempt at a sketchy outline" of a definition of freedom. This is fair enough; but I think that Long will agree that it is difficult to bring the precise power of logic to bear on a definition as diffuse at that. However, the situation can be salvaged after all. I accepted Hathaway's definition, and Long says that he makes the same point as that contained in the following statement by Hathaway: "Notice that this concept of freedom implies both his *ability to choose* to do an act or not to do an act, and the actual *ability to carry out that act* if he should choose to do it or not do it." (The italics are Hathaway's.) Fine. We both accept this statement; we are on common ground. I maintain that the *ability to choose* inheres in the individual. All normal mature people, *as individuals,* have the ability to choose rationally. That characteristic is part of man's nature and is not derived from social processes. Since this ability to choose is an essential part of man's nature, he has the right to use and develop that ability. *This right must then inhere in the individual.* And it is an inalienable right: an *objective* value. Its existence derives from the nature of man, not

[1] *This Journal,* November 1954.

from his subjective tastes, although man *also* has a subjective desire to exercise the ability to choose. So much for man's *"ability to choose to do an act."* His *"ability to carry out that act"* depends on environmental circumstances. These include the physical environment, his own capabilities, the acts of other individuals, and actions taken by sundry social groups. These circumstances determine whether, and to what extent, man's *rights and other values* can be realized. Although Long accepts Hathaway's statement formulating the two aspects of freedom—the value and its realization—Long continues to deal almost exclusively with the latter aspect: "his ability to carry out that act." As I pointed out in my note, this aspect is important; but it is not the whole story by any means. And as I suggest below, even his treatment of this aspect is partial.

2. On this point the issue is whether or not values inhere in the individual. I *still* criticise Long for ignoring "the fundamental distinction between values and the acts and circumstances through which values are realized." With regard to *objective* values like the *inalienable rights of man,* the distinction appears to be quite clear. Hathaway's quotation (which Long says he accepts) directly implies this distinction as far as freedom is concerned. And, as pointed out above, the *right* to freedom inheres in the individual even though the *realization* of that right depends on environmental circumstances, including the social. Also I think that most of us would agree that the Jews in Germany and Russia had a right to life even as they were being killed. Contrary to Long's statement, the fact that modern techniques of persuasion may have led some of these people to "choose" death does not contradict my argument because the *right* to life is an *objective* value, an *inalienable* right. Long appears to reject the point that our Founding Fathers appreciated so very well—*not all human values are subjective.* But even with subjective values the distinction remains. Granting that the desire for lobster is culturally conditioned, that desire still is different and distinct from the lobster and its acquisition. Whether or not *subjective* values are culturally conditioned is *not an issue at all.* Nobody denies that individuals are conditioned by their environment. But this is not relevant to the question of whether or not values inhere in individuals.
3. Long and I agree that social relationships are necessary for the fullest development of man. However, I reject Long's version of Hobbes' war-of-all-against-all as a basis for social policy. If one starts with this view of the nature of man, he obviously is led to emphasize (unduly, I suggest) external restraint. I grant that external restraint

is necessary to order in society; although I do believe that such restraint should be held to the minimum necessary to achieve order. My objection is that Hobbes' view of the nature of man is only a *partial* view, and I would have social policy based on a view of the *whole* man. The whole man includes the desire to *cooperate* as well as the desire to *exploit*. Hence in my note I emphasized the voluntary, partly as an offset to what I considered (and still consider) Long's overemphasis on external restraints. According to my view of the nature of man, voluntary cooperation has a higher value than enforced coordination.

4. Long admits that one can have security without freedom. Yet he exhibits a manifest urge to identify the two, thus escaping the problem of conflict between these values. I merely wish to emphasize that in certain circumstances these values *do* conflict, and that this *conflict* is a serious social problem worthy of our most exacting and precise analysis. By the same token I entirely agree with Long when he says that this problem cannot be analyzed by the glib use of slogans.

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RICHARD T. ELY

THE older men in the field of agricultural economics will remember Ely's interest in our field of work and may have noted that the year 1954 was the centennial of his birth. Richard T. Ely was born on April 13, 1854. He was an honor student at Columbia College, New York City, and received a fellowship which enabled him to study in Europe. He first studied philosophy but soon changed his major to economics.

While studying with J. Conrad in Germany, Ely came to see the importance of agricultural economics, and when he settled down, at the University of Wisconsin in 1892, he commenced to encourage young men to study the economic problems of agriculture. Later in life he specialized in land economics. R. T. Ely, along with L. H. Bailey and T. F. Hunt, may be said to have opened the door for agricultural economics in the United States.

Wisconsin celebrated the 100th anniversary of Ely's birth last spring. On April 13, Artus, the honorary economic society, devoted its meeting to memories of Ely as the founder of economic research and education at the University of Wisconsin. The Wisconsin Historical Society set up an Ely exhibit which was open to the public throughout April and May. That exhibit portrayed the high points of Ely's career at Wisconsin. It

included his writings, his correspondence with many outstanding thinkers of his time, and photographs of and letters from his students who attained high positions in the work of the world. On May 6, the economists of the University sponsored a dinner to commemorate the birth of their one-time leader.

In the statements made at the Ely dinner stress was laid upon Ely's methods of teaching, upon his interest in economic institutions, and the outreach of his mind into the environing world, its activities and its thoughts, all of which did much not only for his students but for the whole University in aiding the faculty to avoid ingrown provincialism and maintain a cosmopolitan point of view.

Ely was a master at stimulating group thinking: thinking in which each member of the group contributes pertinent facts and relevant interpretations; thinking in which the will-to-conclusion is relaxed; thinking which seeks the truth. Students who could not think found Ely's classes intolerably dull, while those who could think found the same classes inspiring. Dean E. A. Birge one time said, "I do not understand Ely. He breaks all the conventional rules of good teaching and yet he has something unique. He has a way of giving his students a stimulus that last." In his teaching Ely understood the importance of paucity. He did not give the students the answers but stated the problems clearly and stimulated his students to diligently seek the answers. With Ely there was no finished system of economics. What he emphasized was securing as clear a mental picture as possible of the economic world of our day in its historic setting and the importance of striving to understand the static and dynamic forces and conditions which guided production and determined the distribution of wealth.

Ely's greatest contribution was in the field of economic institutions with especial stress in the later years on land economics. He started his course in the Fundamental Institutions of the Present Socio-Economic Order, in the 1890's, by taking a text from John Stuart Mill, ". . . the Distribution of Wealth . . . is a matter of human institutions solely." That course of Ely's was a great step ahead in the teaching of political economy in the United States. As time went on Ely broke this general course on institutions into segments with specific titles like Land Economics, Monopolies and Trusts, Custom, Contact, etc.

"Look and see" was a phrase used often by Ely. What is more, he acted upon this principle. When there was a labor problem at the Pullman Company he went and studied the facts first hand. When social economic experiments were being tried, such as that of the Amana Society, Ely studied some of them on the ground. When the Night Riders took control in Kentucky and decreed that no Burley tobacco should be grown

in 1908, Ely went to Kentucky to secure first hand information, see the empty tobacco sheds, and talk with the people involved. When new land problems arose with the development of irrigation he spent a summer studying irrigation institutions in the Rocky Mountain States. Having read much of the social and economic experiments in Australia, Ely made a trip to that distant land to see for himself how the new theories were working out in practice. Ely not only went to see, but he supplemented travel by means of an extensive correspondence with leaders in many lands.

One other characteristic of Ely's work was the use he made of the hypothesis. While many of his contemporaries devoted their time to clever reasoning from accepted assumptions, Ely put in most of his work testing the hypotheses. He worked primarily behind rather than in front of the thesis. It was characteristic of Ely to bear in mind that dogma is dangerous. He was aware that new facts may be discovered or new interpretations placed upon available facts which may modify the appearance of things.

The 100th anniversary of the birth of Richard T. Ely inspired many, both faculty and students, to renew their efforts in the field of institutional economics, to the end that the growth of our economic institutions may more nearly keep pace with the evolution of industrial society and bring into our national economy happier relations among the occupational groups that make up human society. Put in terms of agricultural economics, the outstanding need of today is the perfecting of economic policies and institutions in a manner which will put farmers in a position to secure a fair share of the national income and at the same time leave them that freedom of thought and action essential to efficient production and to a congenial atmosphere in which to live.

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JOHN LESLIE TENNANT

A LIFE devoted to service to agriculture ended in the passing of John Leslie Tennant on Friday, September 24, 1954, at Mount Dora, Florida. Born in Brantford, Ontario, in 1881, his life work embraced farming and careers as educator and agricultural economist.

Dr. Tennant was educated at the University of Toronto and Cornell University. He received his doctor of philosophy degree from the latter institution in 1928. He served as an agricultural extension worker in several Canadian provinces and in Texas. Dr. Tennant was a teacher in the public schools of New York and New Jersey and also at Clemson College, Cornell University, and Rhode Island State College (later the University of Rhode Island). He was appointed associate professor of agricultural economics at Rhode Island State College in 1928 and became department head in 1937. He served in this capacity until his retirement in 1951. His fields of interest included dairy and poultry marketing and farm management; most of his publications were in these areas.

On leaving Rhode Island, Dr. Tennant received an appointment as visiting economist at the University of Florida to do research in citrus marketing. He retired again in 1953, this time to the new home he had built in Mount Dora, where he spent his time golfing, reading and studying. Only a week before he died he and Mrs. Tennant had returned home from an 8,000-mile automobile trip to the Pacific Northwest.

Dr. Tennant's friendly personal characteristics endeared him to all who knew him. When presented with a gift of money on his retirement from the University of Rhode Island, he directed that the entire sum be used as a fund to aid needy students. This was indicative of the character of Dr. Tennant and of the high esteem in which he was held.

H. G. Hamilton
C. N. Smith

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BOOK REVIEWS

Farm Appraisal, Classification and Valuation of Farm Land and Buildings (Third Edition), William G. Murray, Ames: Iowa State College Press, 1954. Pp. 366. $4.50

This book will undoubtedly take its place as the standard text for both practitioners and students in the field of farm valuation, occupying the same position as its two predecessors of the same name and by the same author. Although the same general format is used as in the earlier editions, the book has undergone substantial improvements and modernization in content.

Part I, formerly called Introduction, includes a new chapter on value, valuation, and the types of appraisal. This chapter gives the reader a conceptual orientation of the subject matter of the book, in contrast to the somewhat abrupt consideration of the appraisal process itself which characterized the first chapter of the earlier editions.

Part II, on classification, is unchanged in chapter organization but is expanded in content. The section on farm maps has been enlarged and more complete information is given on soil. The greater attention paid to yield predictions is appropriate in view of the perpetual need for such data in farm appraisal, and the progress being made by soils technicians and agronomists in supplying these data. The new section on pasture yields in Chapter 8 is a tacit recognition of a deficient area in farm appraisal, namely pasture evaluation. Greater attention might have been given to economic implications of alternative types of soil ratings. Likewise in Chapter 11 the author might have given more emphasis to the economic implications of various physical production ratings. An example is the tendency of ratings based on crop yields to overestimate the income productivity of less productive land as compared with land of higher productivity.

Part III includes three new chapters, dealing respectively with building values, valuation for tax assessments and loan appraisal. The coverage on farm building values has been considerably expanded and revised, and should prove very useful. More attention has been given to the problems associated with the derivation and use of building cost data. The problem of surplus buildings has been considered.

In Chapter 22 Murray takes note of special problems and techniques peculiar to valuation for tax assessment. Actually the entire book should be useful to tax assessors as its study is background necessary to the utilization of this chapter. In previous editions the loan appraisal forms used by lending agencies were shown in an appendix. They are now included in Chapter 23 along with an evaluation of loan experience. This procedure

is very appropriate at a time when farm lending activity is increasing. The author's cautions on the selection of interest rates for capitalization (p. 200) are appropriate. In appraisal work there has been too little recognition of the sensitivity of the capitalization process to the interest rate as compared with the other variables used.

Without minimizing the usefulness of this book, this reviewer is inclined to question the bases for the author's preference for the rental method as compared with the owner-operator share method of computing income estimates. The alleged simplicity of the former is not necessarily indicative of its incisiveness as a valuation tool. Indeed the uniformity of customary rental terms between quite different soils in an area leaves this method also open to question. Further, the effect of extreme competition for land by tenants in a local area, or the reverse, can be a source of difficulty. More attention could well have been given to the owner-operator method.

In general the book is very readable and interesting. It is organized in logical fashion, taking up valuation problems in the same sequence as they are likely to occur in an actual appraisal. It abounds in useful and up-to-date illustrative data. These data are of such nature as to be useful for many purposes. At the same time they serve to give empirical meaning to the conceptual points that are developed. Professor Murray's ability to combine principles with illustrative material is in evidence throughout the entire book.

HOWARD W. OTTOSON

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International Handbook of Cooperative Legislation, By Laszlo Valko, Pullman: State College of Washington, 1954, Pp. xi, 273. $5.00.

This book is the first of a contemplated two volume study of the subject. The present volume presents a digest of the cooperative legislation of the countries of Europe. A second volume, in preparation, will present a digest of the cooperative legislation of other continents and the United States.

The present volume consists of an introduction, a short summary chapter on developments in cooperative legislation and 20 sections dealing with the cooperative legislation of 20 European countries, including the Free Territory of Trieste. The cooperative legislation of the Baltic States and Danzig is summarized in Appendix I, and a bibliography is presented in Appendix II.

There has long been a dirth of satisfactory material relating to cooperative legislation, particularly to that of foreign countries. The only analytical work of this kind relating to cooperative laws in this country appeared

in 1927.[1] In 1940 an abstract of cooperative incorporation laws was prepared by Dr. V. T. Tereshtenko with the assistance of the Federal Work Projects Administration. The first and only previous comprehensive digest of the cooperative laws of foreign countries was that compiled by The Horace Plunkett Foundation in 1933.[2]

The present volume by Dr. Valko is, therefore, a welcome addition to the literature on cooperative legislation. As stated in the Introduction, this book "... is primarily a reference book designed as a guide for people desiring to become acquainted with the legal status of cooperatives all over the world."

Dr. Valko adhered closely to his stated purpose to present a factual statement regarding the cooperative legislation as revealed by the various types of enactments, including 1550 different laws, orders, ordinances and decrees. The compilation is, therefore, primarily a descriptive analysis of the contents of such documents. The student of cooperation will miss an attempt at an interpretation and analysis of the economic implications of the legal provisions, and an appraisal of European cooperative associations, in the light of the criteria provided, by some kind of a theoretical frame of reference as to the economic nature of a cooperative association. But, in spite of the many difficulties involved, Dr. Valko has succeeded in presenting an informative panoramic view of one hundred years of developments in cooperative legislation in Europe.

Some of the important impressions gained by the reviewer of this material will bear brief mention.

The enactments of some of the countries involved in the study are much more specific and prescriptive than others. In general, however, the basic cooperative laws are in the nature of enabling acts, which confer a legal status upon cooperative associations and present a general framework, or prescribe only minimum requirements, as a means of safeguarding the general cooperative character of the organization. Considerable scope is thus provided for cooperators to make adaptations in the light of conditions and circumstances, or to suit their purposes and interpretation of the cooperative mode of functioning and methods of effectuating it. Thus, as Dr. Valko says, the real character of cooperative associations is reflected less accurately by the provisions of the basic acts than by the provisions of their articles of incorporation and by-laws. Analysis of articles of incorporation and by-laws, however, was beyond the scope of Dr. Valko's study.

One is impressed with the mass of legislative enactments, particularly

[1] Nourse, E. G., *The Legal Status of Agricultural Cooperation*, The Macmillan Company, New York.

[2] Digby, Margaret., *Digest of Co-operative Law at Home and Abroad*, P. S. King & Son, Ltd., London.

in recent times. Of the 1550 enactments reviewed in the book, 695, or 45 percent, were dated 1930 or later. Among the factors contributing to this dynamic legislative activity, according to Valko, were the rapid developments in cooperative activity, wars, economic depressions and political instability.

In some countries, however, the basic legal framework is of long-standing. A large part of the enactments consist of modifications and adaptations to changing conditions and experience. For example, Finland has not modified her basic law of 1901. The Swedish law of 1911 was not replaced until 1951. The legal basis of Austrian cooperatives is still the cooperative law of 1873, with some important amendments. In Germany, the law of 1889 is still basic. However, what has happened to the character of cooperatives in countries where radical changes in political institutions have occurred is illustrated by cooperative legislative developments in Yugoslavia, Italy, Spain and the Baltic States.

Other observations are:

(1) There appears to be a great diversity in the legislative provisions in the different countries.

(2) There is a growing realization on the part of most European governments of the importance of cooperative self-help activities as a means of promoting welfare.

(3) In many countries there is a most intimate relationship between the cooperatives and the government, sometimes to safeguard the interests of the people, sometimes to speed up cooperative developments, but sometimes for political reasons.

(4) Membership in cooperatives involves a much more rigorous discipline in most European countries than in the United States. In many countries a member may not withdraw until after 2 to 8 or 10 years. Members are more generally obligated to finance and patronize their cooperatives. Members are often required to assume unlimited or joint liability, and such liability may continue up to 5 years after withdrawal.

(5) Getting a cooperative "registered" (legalized) often involves onerous requirements. In Turkey, a list of the members *with their signatures* must be filed every six months. In Italy such a list must also give the name of the father of the member.

(6) Management in general is closely supervised. In Norway, the manager and at least one member of the board of directors must, among other legal requirements, take an examination in an authorized school before the cooperative may obtain a "trading license." In Greece, a person cannot serve as manager or as the head of a financial service of the cooperative association unless he has a certificate from a cooperative school, or from a secondary agricultural, commercial school or university. Auditing, including a scrutiny of the management, is usually mandatory and is

often a function of the state, even in Central Europe. This function may, however, often be delegated to federations of cooperatives.

(7) A satisfactory legal definition of a cooperative association as such has apparently not yet emerged in European legislation.

FRANK ROBOTKA

Iowa State College

The New England Fishing Industry, Donald J. White, Cambridge: Harvard University Press, 1954. Pp. xvii, 205. $4.00.

In *The New England Fishing Industry,* Professor White presents the results of careful study of the present position and problems of this important segment of the sea food industry. He sketches the background of New England fishing and fish marketing, and treats critically and constructively the profit sharing controversies that result from its system of wage payment to fishermen, the decline in population of marketable species through excessive exploitation, marketing difficulties caused by consumer preference, and the effect of imported fisheries products. He challenges the industry to go forward by intelligently planned cooperative efforts of management and labor alike, by research, by cost reductions, and by market expansion.

Professor White outlines the directions in which the industry has advanced and those in which it has remained retarded. He covers the development of trawling and the modern fishing vessel, the introduction and effect of refrigeration, filleting and improved transportation ashore. He describes the principal New England fishing ports and the practices of fishing vessel owners and fish merchants. He describes the organization of the industry, the problems of profit sharing, of supply and of markets. He outlines a program for constructive union leadership and its probable beneficial effects upon all branches of the industry.

In conclusion, Professor White makes clear his belief that the difficulties of the New England fishing industry are internal rather than external, and subject to betterment or cure only through vigorous cooperative effort of all concerned. He challenges the Atlantic Fisherman's Union to lead in the formulation and operation of a forward looking program and makes a clear case for their qualifications to do so. He recommends that the Union improve the price-making arrangements of the primary market, that it organize and support research, that it aid in market development and that it seek to evolve better industrial practices. He points to the existence in Woods Hole, Massachusetts of scientific and engineering laboratories that can make great contribution to the solution of fisheries problems, *if requested or encouraged.* He points to the invaluable aid long rendered to the industry by the Fish and Wildlife Service. He doubts the ultimate value of dependence on continually increasing import duties.

In the opinion of this reviewer, Professor White's book is a realistic account of the position and the problems of the New England fishing industry, offering a sound program for constructive action. It is timely, thorough, practical and well presented. This reviewer fully agrees with its findings, conclusions and recommendations.

There are two aspects of the New England fishing industry, however, that Professor White has not seen fit to include in his work, on which some brief comment may be appropriate.

The first is the engineering aspect, which Professor White has wisely left to the engineer. The fishing vessel, in the broad sense, is the most critical and the most costly tool of the fishing industry. Since the introduction of trawling with steam and diesel propulsion the fishing vessel has become increasingly mechanized, complex and costly. Yet the vital necessity for sound engineering in design, construction and operation is to an alarming extent unappreciated by fishing vessel owners and operators. There should be a comprehensive engineering study of New England fishing practices parallel to Professor White's economic investigations, if efficiency and safety of operation are the goals that the industry is seeking.

The second is the opportunity aspect. In the opinion of this reviewer, the New England fishing industry has a unique opportunity to assert an outstanding leadership in the development of modern fishing, a leadership that will react to its own benefit and to the advance of fishing efforts everywhere. If the New England fishing industry could view its role imaginatively and boldly, it would take full advantage of the superb educational, scientific and technical facilities and skills of New England to develop the tools and techniques of the fisheries to the fullest possible extent. It would recognize the future importance of sea foods in a world of growing populations and increasing food requirements, and would understand the value of research and development on a scale that only the United States can afford. To do so, the industry must acquire new goals and a new sense of cooperative effort.

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Big Enterprise in a Competitive System, A. D. H. Kaplan, Washington, D.C.: The Brookings Institution, 1954. Pp. 269. $4.00.

Probably no question is more baffling than the place of big enterprise in our competitive system. The importance of this problem is highlighted currently by the wave of mergers which are attracting widespread attention.

The book before us represents several years of study and empirical work by the author and his associates. Its declared aim "is to explore those aspects of big business participation in American industry that may reveal whether it is or is not compatible with the objectives of competitive private enterprise." Attention is focused on some three hundred industrial corporations, each with total assets above $50 million and payrolls of more than 5,000 employees.

Following a review of "the changing facets of the big business issue as they have appeared on the American scene in the past three quarters of a century . . . an attempt is made to define the prerequisites of free enterprise and competition, to suggest criteria by which the competitiveness of the economic order can be tested." The main body of the book is divided into two parts: "the first deals with the quantitative measurements for interpreting the position of big business in the national economy; the second with the evaluation of the performance of big business—the effects of size and product leadership on business motivations and on the forms of competition which they tend to emphasize."

In this review we must pass over much of the interesting descriptive material which shows the pervasiveness of Bigness in the national economy. The statistical chapters which leave the impression that new giants are continually replacing old giants are interesting but do they forecast the future as much as they portray the past? This is a question that seems to haunt the author, especially since the average size of the giants is increasing, for in his concluding chapter he says:

> "The larger big business becomes, the greater the need to make sure that it is not becoming bigger and more ramified than is essential for maximum efficiency within the frame of competition."

He also states:

> "It may be that the growth of population and national production will continue to provide ample scope for the general expansion of the large industrials in a climate of ever-evolving opportunity. But it is also conceivable that the progressive expansion of the big business will intensify its problem of how to carry great overall size without becoming economically sluggish, how to direct its expansion into areas where it may compete effectively and grow vigorously without increasing the social onus of oversize."

The major issue of the study, in the author's view, boils down to two basic considerations:

> "First, has the growth of big business tended to narrow the opportunities for new enterprise by concentrating employment, assets, and market control in the hands of a few industrial giants? This is the problem of the *structure* of industries and markets in which big business operates. Second, is the competition in which big business engages of a kind that is regulated in the last analysis by big business policies or by the market forces inherent in the system itself? This is the question of competitive *performance*."

To his credit, the author does not try to give precise answers to these questions. However, in effect, his view is that the growth of big business has not unduly tended to harm the opportunities for new enterprise, and that the market forces inherent in the system itself regulates big business, rather than vice versa. This is emphasized in the final paragraph of the book:

"In our economy big business undertakes the major role of coordinating individual efforts and resources into collective achievement. This is a function that must be undertaken under modern technology, whether by private enterprise or by the state. In the United States it has been possible so to mix dispersion with centralization that the major job can be left to private competition, under government regulation. Big business has not merely been kept effectively subject to a competitive system, on the whole it has also made an essential contribution to its scope, vitality, and effectiveness."

With this skeletonized version of the book before us, how conclusive are the findings? Can we go about our business with the complacent assumption that big enterprise is a benevolent force which cleanses itself through dynamic achievement? It is to be hoped that any popularized conclusion of this sort will not keep readers from digging for the real meat in this volume.

There the reader will find that many points are not black or white. Granted that if big business will accept social responsibilities we have little to fear. Yet who is to persuade big business that this is also good business? Are the satisfactions of service strong enough as motives in a competitive world? Is power something that must be matched by external restraint? These questions keep on emerging.

The reviewer is not unhopeful of the trend toward the assumption of greater responsibility within the business community, but he feels that the trend has hardly gone far enough to relieve public policy of any concern relative to the problems of bigness.

Of particular interest to the reviewer is the question of how bigness affects our daily lives. Can big enterprises be decentralized and localized so that they are unobtrusive and not controlling? The author does not preach complacency. Rather, he looks with favor on "the instinctive resistance in the American tradition to any entrenchment of the final decision-making power of business in a few vast organizations."

There seems little question but that bigness is with us and will remain with us. How does one live with it—as a minion or vassal, or as a master?

Are there self-corrective forces at work which will always see that bigness does not become oppressive? Perhaps public opinion is one—but this is given little attention in the book. Perhaps arrangements for facilitating new forms of competitive enterprise can be given greater encouragement.

Although the yardstick activities of the Tennessee Valley Authority and the Rural Electrification Administration are not mentioned, the author attributes substantial benefits from the government's encouragement of competition in the case of the aluminum and petroleum industries.

In some cases small enterprises have combined to get many of the economic benefits of bigness without having this status, as in the case of voluntary chain store systems and pooling arrangements for carrying on research. It is of interest that Dr. Kaplan made much of this point in his book of a few years ago for the Committee for Economic Development, *Small Business: Its Place and Problems.*

In agriculture, farmers have long been concerned with the problem of bigness—selling products to and buying supplies from large firms. To remedy this position some 3,000,000 have joined in cooperative organizations which employ the principle of integration both horizontally and vertically. Some of these enterprises are big—they have to be if they are to survive in a world of bigness. Yet they are democratically controlled by the individuals who comprise them.

Here is a response to bigness by bigness comprised of an agglomeration of small business enterprises which may help to keep competition active. No reference was made to these important organizations in Dr. Kaplan's study, and it is hoped that in the future case studies which are planned at least a few of the major farmer cooperative associations may be included.

This book is a valuable anatomical study of Big Business. It deals realistically with such perplexing problems as price competition and market leadership, the significance of integration, research and innovation. Perhaps it raises as many questions as it answers but it opens up avenues in the search for ultimate truth.

JOSEPH G. KNAPP

Farmer Cooperative Service

An *Economic Analysis of the Impact of Government Programs on the Potato Industry of the United States*, Roger W. Gray, Vernon L. Sorenson, and Willard W. Cochrane, North Central Regional Publication No. 42, Minnesota Agricultural Experiment Station, 1954, Pp. 239.

This publication contains an analysis from a historical perspective of the effects of the recent government programs upon the potato industry. The major portion of the report is devoted (1) to a description of prices, production, and consumption behavior in the potato industry prior to the advent of government support programs, (2) to the isolation of the forces determining the behavior of these variables, and (3) to a description and analysis of the effects of the support programs upon the potato industry.

Per capita potato consumption in the United States increased between 1870 and 1909 and decreased sharply thereafter. The increase in consumption is attributed to the relatively large migration of people to the United States from European countries in which potatoes constitute a major item in the diet. The decrease in consumption is attributed to a change in numbers and in origin of immigrants and to "economic development" in the U. S. As a result of the "economic development" the demand for potatoes has become very inelastic.

Within the industry, the decline in per capita consumption was accompanied by a shift in production from the corn belt to the "lake states" and to the potato "specialist states." Yields per acre are higher and more stable in the specialist states. Prior to the price support programs, expansion of production in the specialist states was limited by relatively high transportation costs, by the relative profitability of potatoes and their continued production in the lake states, and by the larger risk associaated with production in the specialist states as compared with the risk in the lake states. The larger risk resulted from greater fluctuations in per-acre value in the specialist states. Producer behavior has been characterized by the continuously oscillating cobweb model. The lake states had been contributing a larger share of the total production and tended to be price makers and risk makers for the specialist states (p. 82).

The government price support programs were injected into this setting. The levels of support prices were not high relative to the prices of other farm commodities. In effect, however, the establishment of a support price placed a "kink" in the demand curve and the curve became highly elastic at the support levels. This change in the demand curve broke up the cobweb behavior, and as a result of the decrease in the price risk, the supply function shifted to the right through the encouragement of production innovations. Hence, supply exceeded demand at the supported price levels and surpluses of potatoes accumulated.

Consumers of potatoes benefited from the program as a result of decreased potato prices. Society, on the other hand, incurred losses due to net government expenditures for purchase, diversion, and subsidization of potatoes and due to the fact that more resource services were expended in potato production and less in the production of other goods and services. The support program was costly to potato producers in that it "actually reduced the total incomes of potato producers" (p. 137).

The authors expect the cobweb behavior of potato producers to reassert itself. Based upon this assumption they consider means of decreasing instability of production and prices. The futility of single producing regions seeking to increase gross receipts via market restrictions is emphasized and an "income schedule plan" is advocated. This plan would kink

the demand curve by guaranteeing relatively high levels of gross receipts corresponding to particular levels of output greater than the quantity that would clear the market.

In the opinion of the reviewer the manuscript would have been improved if the authors had confined their efforts to an "objective" analysis of the consequences of the program. As recognized by the authors, such questions as "Were acreage allotments fair?" and "Were price determinations fair?" are moot questions. Levels of price supports and apportionment of allotments can be appraised only with reference to specified objectives. The real questions concern the objectives of policy and consistency of means and objectives.

The reviewer finds it difficult to reconcile the conclusion that the program resulted in a reduction in total income of producers (p. 137) with the conclusion that the program resulted in more efficient production by providing high producer incomes and capital needed for production innovations (p. 145). Furthermore, one can hardly overlook the surpluses that accumulated under the program. A decrease in incomes of producers could have resulted from the program if producers were willing to accept a smaller, more stable income in preference to a higher instable income or if producers responded to an appeal from the government for increased production without reference to the effects of increased production upon income.

The authors contend that their "income schedule plan" is not a price support program. The reviewer would contend that, if the program is to give stability to the industry, it must become essentially a forward price program. That is, producers must translate the guaranteed total receipts from the sale of potatoes into expected prices at the farm level. Also by decreasing price risk the proposal likely would result in shifting the supply function and hence would result in somewhat higher production than would clear the market. In order to avoid this surplus the demand curve could be kinked at a price slightly below the free market equilibrium level.

The form of the equation estimating changes in acreage of potatoes (p. 123) likely was intended to read

$$A = a + b\,\frac{(P_{t-1})}{I_{t-1}} + c\,\frac{(P_{t-2})}{I_{t-2}}.$$

This publication is a comprehensive report. It will be remembered as a significant publication in agricultural economics. It should be of great value to professional economists and to the potato industry.

CHARLES E. BISHOP

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Wartime Agriculture in Australia and New Zealand, 1939-50, J. G. Crawford, C. M. Donald, C. P. Dowsett and D. B. Williams; and A. A. Ross, The Food Research Institute, Stanford: Stanford University Press, 1954. Pp. xiii, 354. $7.50.

This book is essentially a two-volume work—a 237-page study of the Australian agricultural economy during the years 1939 to 1952, written by the first four authors, together with a similar 117-page study of New Zealand agriculture from 1939 to 1950 by Mr. Ross. The word "wartime" in the title therefore gives a somewhat misleading impression of the scope of the book. The authors offer some justifications for their elastic interpretation of the term, one of which is that the lapse of time between 1946 and the writing of the final chapter "justifies something more". Nevertheless the reviewer is strongly of the opinion that a more intensive study of wartime agriculture in the two Dominions would have been preferable to the present work covering the greater part of two decades. In any case, a good study of the new phase of Australian agricultural policy which began about 1951 has already been published by the senior author. Perhaps the real need was for two separate books, one on Australia and one on New Zealand, rather than the present double-decker volume which was prompted perhaps by the impression, quite widespread in the United States, that these countries have identical problems and share a common government.

The general treatment of the subject matter in the two sections of the book is similar. A background description of the agriculture of each country is followed by a general account of wartime developments, heavily biassed in the direction of treatment by commodities. Then follows a discussion of difficulties associated with the supply of manpower and materials. Both sections contain chapters on wartime distribution problems. In the Australian section a whole chapter is devoted to price policy whereas in the New Zealand section rather more emphasis is placed on marketing arrangements. The final chapters in each case summarize wartime experiences and describe developments well on into the nineteen-fifties. This method of handling the subject matter probably necessitates some repetition, but the not inconsiderable repetition which (in the New Zealand section even extends to phraseology) becomes tedious to the reader.

The Australian section of the work, with one major exception noted below, is written largely in the form of a historical narrative, and contains rather less evaluation than is attempted by Mr. Ross for New Zealand. From a historical standpoint, the documentation is both inadequate and uneven. That the Australian study is essentially descriptive rather than analytical is probably to be explained by the fact that the authors were all intimately associated with the wartime policies described. To have been in this position gives the authors unrivalled insights into their

subject but it also places them at a grave disadvantage. They can never be regarded as wholly objective appraisers of the policy and administration, of which they themselves were, to a varying extent, the architects and executors.

The authors' major criticism of Australian agricultural policy in wartime was that the Government failed to use the price mechanism to achieve production objectives, but instead relied heavily on manpower and materials controls and cajolery to this end. With this conclusion there can be no quarrel. During the war responsibility for the administration of prices was vested in the Prices Commissioner, Professor (now Sir Douglas) Copland, who acted almost completely independently of the agricultural administration. The preoccupation of Australian price-fixers with stabilising retail prices has severely prejudiced Australian agricultural development from the time it was introduced in 1943 right up to date. The fact that at the outbreak of the war, agriculture was in a state of disequilibrium relative to the rest of the economy contributed in no small way to this particular trouble. It would appear that substantially the same was true of the New Zealand administration. Assuming this criticism is not merely a matter of hindsight, the reader is left wondering why these rather obvious facts were not recognised in 1943 and powerful representations made to the respective Dominion Cabinets. The authors refer to the administrators' confidence in direct controls and there is no doubt that this was a potent factor. The distribution of gumboots and horse collars unfortunately received more administrative attention than the terms of trade.

Considerable emphasis is placed on the pessimistic bias of farmers' expectations during and after the war, in explaining the failure of agricultural production to respond. One is tempted to ask whether this is not yet another example of administrators' imputing their own valuations to farmers. The negative view of agriculture contained in wartime official documents like the Australian White Paper on full employment, lend credence to the view that the administration was at least partially responsible for the farmers' attitudes being what they were.

The dilemmas of wartime food distribution are emphasised particularly in the Australian section. The authors appear here to complain about lack of precision where no precision could exist. Much of the discussion seems to be premised on the idea that there was some finite demand for foodstuffs during the war. The U.K. Government, and more particularly the U.S. Army, are criticised for their failure to specify their wants precisely. But surely in these latter instances, the need in critical periods of the war was for the maximum amount of many types of foodstuffs that could be delivered.

In the New Zealand section of the book, the issues of the overseas trade

policies of the southern Dominions during the past fifteen years are made explicit, but are not very deftly handled. Against an almost continuous background of retrogression in the terms of trade, balance-of-payment difficulties and import restrictions, we find curious unsubstantiated judgments that the bulk-purchase agreements which were a prominent feature of New Zealand overseas trade from 1939 to 1954 were "very successful" and that "remarkably good prices" were received for primary produce sold overseas. In this connection, it should be pointed out that the quoted figures for the terms of trade existing for both Australia and New Zealand are apt to be misleading. Use of the prevailing low prices paid for food imports by the United Kingdom under long-term contracts in the index of export prices seriously underestimates the terms of trade which might have existed, if the U.K. Government had been pressed at an earlier date for reasonable prices, at least comparable to those paid other suppliers. To say, as Ross does, that "no useful action could be taken by the Government" on this matter is nonsense. The failure even to mention (1) the special provisions whereby New Zealand was compensated by the U.K. Government for any deterioration in New Zealand terms of trade brought about by wartime contractual arrangements, and (2) the appreciation of the New Zealand pound relative to sterling in 1948, in this discussion, is surely a serious oversight.

The book fills a void in the literature on Australian and New Zealand agricultural policy. It should therefore prove extremely useful to students in those two countries. Whether these two short essays contain much of overseas interest on the matter of wartime agricultural administration (a presumable objective of the Food Research Institute's series of studies on Food, Agriculture and World War II of which the book forms a part), the reviewer is more doubtful. But the reason for this lies not so much in the authors' workmanship as in the lack of ingenuity of the policy makers.

The indexes, which assume some importance in a book of this kind, could have been better prepared. Errors present suggest that they were constructed by a person who had not read the book in detail or at least had not understood it, and who had little knowledge of Australia and New Zealand.

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The Growth of Physical Capital in Agriculture, 1870-1950, Alvin S. Tostlebe, Occasional Paper 44, The National Bureau of Economics Research, Inc., New York, 1954, Pp. 92, $1.25.

The National Bureau of Economic Research does not often invade the domain of Agriculture with its empirical reseaches, but when it does, it may be expected to do a good job. And the piece of work under review is

no exception. With Dr. Tostlebe doing the heavy numbers work this time, the National Bureau has issued in Occasional Paper No. 44 a concise, yet comprehensive, description of capital formation in agriculture since 1870 (this incidentally is the sixth Occasional Paper issued in a general series called Studies in Capital Formation and Financing).

Dr. Tostlebe organizes his data on capital formation under four principal headings: (1) land and buildings, (2) implements and machinery, (3) livestock, and (4) crop inventories. To aid the analyst, the livestock data are further divided into (a) horses and mules and (b) other. Data under these principal headings are then presented by decennial years from 1870 to 1950 for the United States in the aggregate and for 10 geographic subdivisions. All of this useful information measured first in terms of current dollars and second in terms of constant 1910-14 dollars is presented in two major tables: tables 6 and 8. The meat of the study is to be found in these two tables.

Consumers of Dr. Tostlebe's numbers will, I believe, be unhappy with one of his principal categories, namely, land and buildings. He argues that land should be included as capital. Perhaps he is right, although I am not convinced. But I am certain that land on one hand and buildings on the other represent very different forms of capital. Thus, it seems appropriate to ask—Why were not the data in this category further divided into (a) land and (b) buildings? Perhaps the census data precluded such a breakdown. If so we have the answer; if not a serious mistake in classification was made.

The reader may also be disappointed in that little in the way of analysis is to be found in this report. This reviewer would have liked to have seen these data on capital formation related to output, or production responses, to shed some further light on the nature and movement of the aggregate supply function in agriculture. From the wistful remarks made by Simon Kuznets in the Introduction to Occasional Paper 44, it would appear that he too would have liked to have seen some analytical work in this direction. But the analysis is missing; this report deals *exclusively* with the measurement of "The Growth of Physical Capital in Agriculture, 1870-1950".

To researchers in Agricultural Economics, however, the important points to bear in mind are: (1) some important new data have become available on capital formation by categories and over an extended period of time; and (2) if this research product is a typical product of the National Bureau, then these data are well conceptualized and reliable. From this point the analysts can take over to formulate more meaningful capital-output relations.

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Shirt-Sleeve Diplomacy—Point 4 in Action, Jonathan B. Bingham, New York: The John Day Company, 1954. Pp. 293. $4.00.

This is a most authentic and complete book on Point 4. It was developed from a thorough experience with Point 4 activities and problems associated with them. The author, Jonathan B. Bingham, was Deputy Administrator of the Technical Cooperation Administration (Point 4) from October, 1951 to March, 1953, and for five months starting in December, 1951, Acting Administrator after the tragic death of Administrator Dr. Henry G. Bennett.

Much of Point 4 work is concerned with the development of agriculture in foreign countries and, therefore, this book is of special value to agricultural economists. It is well written and easy to read. It can be recommended for laymen who have interest in the Point 4 program or in aid to foreign people.

The philosophy, objectives, and problems of Point 4 are discussed and also detailed description of the programs are presented. Much of the detailed description and most of the documentation and bibliography are left out of the main part of the book and placed in the Appendix.

The first part of the book describes the new type of diplomat: a government representative working (in shirt-sleeves) with local people in a foreign country trying to help them solve some of their problems in agriculture, industry, health, education, community development and other areas affecting their living.

Some of the events are related which lead up to the legislation starting Point 4 activities in 1950. One chapter deals with the previous work, particularly in Latin America under the Institute of Inter-American Affairs. Perhaps the author does not give enough credit to missionaries, foundations, and private agencies in technical assistance work, both before and since 1950.

Although much work had been done previously on a small scale, there was no blueprint for planning a program for an entire country. The complicated problems and confusion in starting this work is portrayed in a chapter describing activities of a new director in a mythical country.

Interesting accounts are given of a few spectacular accomplishments in agriculture, health, education, community development, and organizational activities. Later caution is expressed in expecting too rapid and extensive accomplishments over a wide area.

A chapter is devoted to the role of private enterprise in technical assistance. The greatest contribution of private enterprise is in supplying capital. However, it is concluded that even with the elimination of barriers to the flow of private capital to foreign areas, this will not supply

enough capital and additional sources will have to be found for development of countries.

Pros and cons of a much larger or a smaller monetary appropriation for technical assistance are considered. Many who propose multi-billion dollar programs are unaware of the difficulties of transferring dollars from this country to foreign countries without causing serious economic troubles in the foreign countries. This is called the dollar fallacy. In contrasting the Government Point 4 work with missionary work, he may accuse unjustly the missionaries with being too content to be satisfied with small scattered achievements. The author concludes that the Point 4 program could be larger than at present and somewhere between 500 million and one billion dollars.

The relations of United Nations Technical Assistance and Point 4 are discussed thoroughly. The author seems to feel that we should not do all of our work through the United Nations, because we would be furnishing such a large proportion of the finances that we would dominate it and be less effective than with our own program.

Mr. Bingham says that probably the greatest single problem confronting Point 4 is finding the right people to work at extraordinarily delicate and difficult jobs. They must be technically qualified, tactful, imaginative and flexible, free of prejudice, physically and mentally fit to withstand strain, and, if married, have a wife with similar traits.

Some space is devoted to our need to recognize that countries which are not developed technically still have a developed culture and that we are likely to fail if we try to impose our culture on them.

The author relates, probably from his own experience, a typical hearing before a congressional committee in which the Malthusian question is raised that the population inevitably will exceed the food production. The final answer is that our only alternative is to do nothing. Difficulties of administering government programs are discussed. The difficulties of developing a new program such as this are immense since the action is carried on in all parts of the world.

The author thinks we must not try to extract political conditions or favoritism from recipients of Point 4 help. In most cases the amount of money in Point 4 is not large enough and it is not just a gift because the recipient countries must contribute toward the development program in their country.

Our main objective in Point 4 according to Mr. Bingham is greater security. It is believed that economic and social progress of free nations contributes to our own security. Point 4 is the only offensive part of our security program as compared with our military defensive program. The Soviets accuse us of imperialism, but if we do not require political con-

cessions, recipients will see the fallacy in such Soviet claims.

Although the Soviets are contributing to foreign technical assistance, it is difficult to imagine that they can participate without imperialism. Point 4 portrays the characteristic of our democracy and our ideals.

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Methods of Crop Forecasting, Fred H. Sanderson, Cambridge: Harvard University Press, 1954. Pp. XIV, 259. $5.00.

In the foreword, the author defines his two objectives as follows: (1) ". . . to present in summary form the contents of a large and scattered literature" (bearing on crop-forecasting methods) and (2) ". . . to subject the recent advances in crop-forecasting methodology to a critical appraisal: to study the relations between the different approaches, to evaluate their relative merits, and thus to arrive at a synoptic view of the various aspects of the crop-forecasting problem."

As the book develops, it would appear to be directed a good deal more toward the first objective than the second. To a significant extent, the book may be characterized as "a survey of relevant literature," in which the author's description of results of research reported is supplemented at the end of each chapter by the rather extensive list of references from which the material was drawn.

Organization of the subject matter is in four parts. Part I, aside from the introductory chapter, is given over to a nontechnical discussion of methods of estimation—sample design and regression. In the sample design chapter, the author undertakes to pull together what he considers to be the more useful results from the growing body of literature on sampling theory and attempts to interpret the significance of these results for the nontechnical reader. This chapter presumably is presented primarily with the view of providing background for appraisal of methods in use. Readers with particular interests in the technical aspects of sample design and in the theory of estimation will find the original literature cited as well as other literature in the field which is essential reading. In the chapter on regression, formulation and development in mathematical terms are avoided at the expense of some sacrifice in precision. This manner of treatment is presumably also adopted to facilitate communication and not primarily to provide a systematic and thorough development of regression theory. The author apparently feels an obligation to give more than the usual attention to discussion of "flexible" procedures in the use of the regression technique. This is perhaps understandable in view of methods used extensively in crop-forecasting practice. On the other hand, there would appear a real basis for questioning whether the ideas that

the author strives to present as background in this chapter have been effectively brought to bear on appraisal in subsequent chapters.

The remainder of the book is devoted to a discussion of methods used specifically for estimating the components of crop production, that is, acreage and yield. Part II consists of one chapter on acreage estimation. Part III consists of two chapters giving attention to methods of yield estimation. The first chapter in Part III considers subjective condition reports as a basis for early season yield forecasts. It is, of course, well known that this is the method underlying virtually all of the yield estimates regularly published by the U. S. Crop Reporting Service. The second chapter in this part is given over to brief summaries of a number of isolated research projects designed primarily to investigate objective plant measurements, supplemented in some cases by weather data as a basis for yield estimates. Research in this country receives most of the author's attention, although some of the more significant work carried on in certain foreign countries is mentioned and literature cited.

Part IV consists of three chapters in which attention is given to ecological factors, primarily weather, as a basis for yield forecasting. This is apparently an area of special interest to the author, and the literature cited indicates a rather extensive survey of what is available in the field.

With respect to appraisal of methods of estimation, the critical reader is almost certain to feel somewhat letdown. Indeed, although appraisal is indicated in the foreword as the chief aim of the book, it definitely takes a secondary position as the book develops. Appraisal of the various research projects undertaken over the years in the field of crop estimation takes the form of a few rather cursory remarks, supplementing the brief summaries of research results reported. Nowhere is there an attempt to develop an integrated appraisal of the contribution of this research to crop-forecasting practice. Assessment of the over-all contribution of this research to crop-forecasting practice would be difficult since the research studies summarized appear to represent more a collection of independent projects than components of an integrated program. But this would seem all the more reason why such an assessment is needed, and this book would seem a most appropriate place for such an attempt.

Appraisal of crop-estimating methods currently in use in this country is likewise somewhat disappointing. Definitive appraisal is difficult here, also, but disappointment rests more on apparent lack of caution in presenting debatable appraisal comments than on the particular views expressed. The chapter devoted to condition reports as a basis for forecasting yield, for example, consists to a considerable extent of a reaffirmation of many of the points of view expressed in various publications of the U. S. Department of Agriculture, augmented by some general recom-

mendations with respect to the use of objective crop measurement, weather crop analyses, and economic and other variables as bases for adjusting yield estimates derived from condition reports. Throughout this discussion, troublesome methodological points are either dismissed without critical appraisal or are simply not explicitly recognized. (Nowhere, for example, does one find explicit recognition of the troublesome "editing" procedures currently used by the Crop Reporting Service.) It is understandable that the author chooses to omit detailed description of the methods currently in use and refers the reader to available official reports for this background. On the other hand, a systematic and objective appraisal of methods would appear essential to the main objective of this book.

In the same chapter (pages 144-45), the author presents some comparisons of early season forecasts and final estimates of yields and production in the form of correlation coefficients and average departures for selected time periods of ten or more years in length. These comparisons are offered as bases for evaluating performance of yield and production forecasts. In another section (page 106), the hazards associated with such comparisons, arising primarily from the uncertainty surrounding the reliability of the final estimates themselves, have been clearly recognized. It is not the intent here to suggest that these limitations make the inclusion of such comparisons inappropriate, particularly in view of the paucity of more suitable data. On the other hand, the author's cursory interpretation of what these comparisons show adds little to the summary measures presented. The textual discussion occupies the equivalent of about one full page of remarks consisting on the one hand of the claim that the methods have "yielded fairly accurate results" and on the other the claim that "there remains considerable room for improvement." Of course, the comparisons are summarized in table form for the reader's inspection and a certain amount of appraisal on his own. In this connection, the reader may share this reviewer's reaction that the year-by-year detail which is lost in the summary measures presented might have provided somewhat more useful appraisal material. The above remarks concerning the appraisal of yield and production forecasts apply with almost equal force to the acreage appraisal section (pages 103-106).

The author undertakes a somewhat more systematic appraisal of a number of estimated weather crop relations as bases for forecasting yield (pages 218-33). Although certain questions might be raised here concerning the particular testing procedures employed, it seems clear that the equations tested have not performed well in the forecasting problem undertaken. This is not a particularly surprising result and would seem to offer little evidence one way or the other bearing directly on the possi-

bility, suggested by the author, that weather data might serve well in conjunction with objective plant measurements as a basis for early season forecasts of yield and production.

IVAN M. LEE

University of California

Sun, Sea and Sky, Irving P. Krick and Roscoe Fleming, Philadelphia: J. B. Lippincott Publishers, 1954. Pp. 248. $3.95.

It used to be true that "everybody talks about the weather but nobody does anything about it." Today we would want to alter the latter part of the sentence by substituting, "but there are quite a few who are at least trying to do something about it." Dr. Krick is no less than Mr. Rainmaker of the U. S. A. He heads the Water Resources Development Corporation in Denver, Colorado—the largest private commercial cloud-seeders in the world. Yes, *he is* the man who is responsible for the interesting long-time weather predictions that are appearing each month in the *Farm Journal.*

But Krick is more than a salesman. He is a full fledged scientist as well. The fact that he used to be head of the Department of Meteorology at the California Polytechnic Institute in Pasadena, certainly should leave no doubt about his professional qualifications. During World War II he was on Eisenhower's staff where he helped to set up the weather forecasts for the D-Day invasion. Mr. Fleming is an editorial columnist for the *Denver Post.* He knows how to make good reading out of what Mr. Krick has to say.

Artificial control of precipitation could have revolutionizing impact upon agriculture in general, Western agriculture in particular.[1] It therefore would behoove us to develop some interest in these new techniques. It might also be of interest to note that polluted air—i.e., Los Angeles and other smogs—is a negative form of weather modification.

Most people, including those in the U. S. Weather Bureau, are still imbued with a great deal of scepticism with regard to the operational efficiency of cloud-seeding. Not so Dr. Krick. He is a proselyte, who preaches the rainmaker's gospel with tremendous conviction. It is, consequently, only fair to provide the dogma with a grain of salt.

The truth is that, despite much rosy "evidence," we still don't know for sure whether cloud-seeders have really been able to increase precipitation.

[1] Dr. Krick unfortunately has no index of literature in his book and some extremely important references will, therefore, have to be cited. First, we will refer to the interesting paper on "Land Use Potentialities of Artificially Induced Precipitation in the Western United States," *Land Economics,* February 1952, pp. 54-62, by Dr. Marion Clawson, former Director of the U. S. Bureau of Land Management who is presently serving as Land Policy Consultant to the government of Israel. The title fully describes the subject matter.

Dr. Krick's Water Resources Corporation has dozens of successful project reports in its files. The data have been convincing enough to persuade many western ranchers to contract for rainmaking. Similarly, much cloud-seeding is done in the Sierra Nevada, where power corporations (like Pacific Gas & Electric) are trying to pile up snow in order to enhance the runoff and fill reservoirs for times when water is scarce. Actually, rain making is a technique that has been experimentally applied in at least thirty different countries.

In judging the reliability of Dr. Krick's success stories one has to keep in mind the lack of appropriate statistical methodology by which to evaluate effects of cloud seeding. This at the present is one of the major problems. Dr. Jerzy Neyman, Director of the Statistical Laboratory at the University of California (Berkeley), is currently compiling California data with the objective of establishing a method for testing the effects of cloud-seeding. Neyman and his cooperators are looking for data produced under conditions that would make possible a statistical analysis inside a stochastic (a fancy word for "probable-istic") framework. They suggest the following:

> ". . . that contracts between the weather modification companies and the consumers include a clause that would incorporate into the commercial cloud seeding a randomized experiment. In relation to cloud seeding, randomization means simply that roughly one half of the units of observation [of storms or clouds] found to be suitable for seeding should be left unseeded and that the units seeded should be selected at random. This randomness may be achieved by tossing a coin. However, since most coins are slightly biased and since the outcome of a toss depends very much on the method of tossing, it is preferable to use tables of so called random numbers."[2]

Professional rain makers of course have to make a living; they either produce results or their contracts won't be renewed. Dr. Krick is aware of the "stochastic refinements" but the instinct of self-preservation forces him into ignoring the issue. "We just cannot afford to pass up promising clouds, merely in order to satisfy a statistician's curiosity. Our lives are simply too short." This was the straight forward answer[3] that I received from one of Krick's cooperators who helped to set up the rain making program for the government of Israel.

[2] T. A. Jeeves, L. M. LeCam, J. Neyman and E. L. Scott, *On the Methodology of Evaluating Cloud Seeding Operations,* a mimeographed report to the Division of Water Resources, Department of Public Works of the State of California, Berkeley Statistical Laboratory, University of California, April, 1953, p. 42.

[3] I have an academic interest in the cloud seeding issues—an urge which led me into analyzing the "Prospectives for Artificial Rain Enhancement in the Jordan Valley Development," *The Middle East Journal,* Autumn 1953, pp. 484-498. An inquiry into the reasons why the "Stochastic clause" was not made a part of the contract—an idea directly emanating from Prof. Neyman—brought forth this honest and realistic answer.

Although one might have some reservations about Dr. Krick's enthusiasm, the fact that rain-making—or rain-preventing, because under certain circumstances overseeding can disperse threatening clouds—has passed the crack-pot stage of development, is undisputable. I certainly would agree with the rancher in Washington State who nicely expressed his motivations for participating in a regional cloud seeding contract: "Look mister," he said, "I ain't got nothing to loose. Okay, so it costs me a hundred bucks. But remember that I have five thousand acres in wheat. That makes for two cents an acre. Should that Denver fellow put an extra inch of rain on the place, I'll make money. If not, this is still a pretty darned cheap way to gamble. So what difference does it make whether you learned college guys have confidence in Krick or not? As for me, I think he is okay!"

The sceptic, however, could quote the Utah farmer, who did not renew the contract and who suggested that "Dr. Krick should color the rain, so that I should be able to tell what I am praying for from what I am paying for."

Be that as it may, a couple of evenings in company with the elements of *Sun, Sea and Sky* makes for highly enjoyable and extremely interesting reading.

FRANK MEISSNER

Cornell University

South African Food and Agriculture in World War II, J. M. Tinley, The Food Research Institute, Stanford: Stanford University Press, 1954. Pp. xii, 138. $5.00.

This is a straightforward description of the history of food and agricultural matters between 1939 and 1948 in South Africa. In some respects South African problems were peculiarly intractable. The several sections of her population differed widely in purchasing power, food habits, agricultural practice and enthusiasm for the war. Her exports of farm produce went largely to Britain and Germany. The needs of adjacent territories and of the convoy traffic put very heavy pressure on her supplies of meat and dairy produce. Finally, her agriculture is very subject to the vagaries of weather.

In his first two introductory chapters Professor Tinley gives an outline of the main features of the South African population and agriculture. He notes that in spite of South Africa's capacity to grow a wide range of agricultural products the country is not rich agriculturally. Some 45 percent of the cattle were owned by natives who stress numbers owned above quality, so they are reluctant to sell stock and their economic output is small.

The economic problems of the 1930's had led to the passing of a Marketing Act in 1937 under which marketing boards were set up with very

wide powers. They dealt with the marketing and prices of wheat, maize, dairy products, tobacco, dried fruit, livestock and meat, and chicory, subject to the approval of the Minister of Agriculture. Various other organizations had, in practice, considerable powers over the marketing and prices of fruits, wool, hides and skins, and eggs.

The study then traces the development of regulatory agencies through the period from 1939 to 1945. For the first two years the impact of the war on South African agriculture was slight and no fundamental changes in regulatory machinery were needed. The main emphasis was on disposing, without gross dislocation, of the products that could no longer find an export market. By 1941-42 increased buying power and adverse weather had caused shortages which led to the setting up of a food control organization. The Minister of Agriculture was designated the Controller of Food Supplies and was furnished with wide powers over production, distribution and prices. In 1942 and 1943 this linkage of the food control with agricultural production came in for sharp criticism from the trade and consumers. As a result responsibilities for food control and for agricultural production were separated in early 1944.

At various times bread, maize, meat, rice, tea, butter, and cheese, were so scarce as to fall far short of demand. Those families with small incomes were especially badly placed, for South Africa's nearest approach to a formal rationing scheme during the war was the prorated distribution by marketing boards of certain products to wholesalers and retailers and the limitations on the quantity of a particular food which could be bought at one time by consumers.

In the more detailed discussion of food supply and utilization which Professor Tinley then undertakes, the problem of surpluses and of shortages are treated separately. The remaining review of the war-time situation deals with employment, consumption trends, and price control. The severest test for the South African food administration came after the war, as a consequence of three years of drought, and the record is extended to include this period. On the advice of experts from the British Ministry of Food an individual rationing scheme was planned, but before preparations to put it into effect were complete the crisis passed and it could be abandoned. The book concludes with a satistical summary on supplies and prices, and financial assistance to agricultural producers, covering generally the period 1935 to 1948.

To say that this is a straightforward account of the principal features of food and agricultural affairs in South Africa during and after the war summarizes both the strength and weakness of the book. Details about quantities and prices, legislation and administration, are set out clearly and coherently, but there is very little of the background, of the pressures and cross-currents of opinion and policy, which must have led up to the actual

conduct of affairs. Had this interpretation been given, the record of events in the food and agricultural field might well have been less conveniently displayed, but the study would have gained. The operations of the producer-controlled marketing organizations, the inter-relationships of the food and agricultural producers that were fixed under such an administrative set-up, might have been one possible focus for such analyses. Finally, does the story of this decade hold any lessons for war or peace? A final chapter headed "Summary and Conclusions" held promise that it might, but in fact this chapter is, in the main, a summary.

After making this comment it is only fair to add that the *Preface* and *Acknowledgements* at the start of the book hint at the difficulties Professor Tinley met in tackling his job. Although he knew the country intimately, he seems to have had only a brief opportunity for actual discussion with those who had been personally engaged in the war-time administration. Without the chance to develop and check interpretations by such contacts it is easy to understand why he did not develop these less factual aspects. Even without them, however, the book is a valuable reference to the student of food and agricultural administration.

K. E. HUNT

Agricultural Research Institute
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Law and Practice in Chattel Secured Farm Credit, Glenn R. Coates, Madison: The University of Wisconsin Press, 1954. Pp. xi, 105. $2.75

"Discrepancies" between the existing laws and business activities can often be found in a dynamic economy. It is evident to most of us that laws do not always reflect adequately the needs of the business community. Hence, the laws are either ignored or circumvented in every-day practice. The existence of such "discrepancies" breeds disrespect for the law. Coates' stimulating little volume deals with a specific subject from this problem area. He focuses attention on the relation between the practices of making chattel secured farm loans by lending agencies under existing law in Wisconsin and the proposed Commercial Code. In this phase of credit, business behavior has obviously "departed from legal rules" and the law must "catch up" with commercial practices in order to satisfactorily regulate the latter.

Law and Practice in Chattel Secured Farm Credit is a fairly technical book. Nonetheless its reading is recommended highly to all interested in farm credit because the problems with which the book deals are usually believed to be closely connected with the availability of credit. In the first chapter, the author gives a summary exposé of the existing law in Wisconsin—which is typical for many states—and the types of secured credit

instruments in use by lenders, such as chattel mortgages, conditional sales contracts, milk check assignments, etc. The law stresses principles that are obstacles to modern credit needs, particularly with regard to the enforcement of the security: (1) The rule that property has to be in existence and owned by the farmer before that property can be mortgaged to the lender. Under this rule, for example, an agency loaning money to enable a farmer to buy a tractor at some later time of the farmer's choosing, cannot validly obtain a mortgage on this equipment at the time of the loan contract. (2) The rule that a debtor cannot sell assets serving as security. This may void or diminish the lender's security, as when, for example, a farmer sells the harvest which is encumbered.

The practices of making secured loans on crops, livestock, equipment, etc., and the various attempts at circumventing the law, and the legal effect of the "circumventing" methods, are described in chapter II. This section is particularly interesting because it shows to what extent the legal obstacles to chattel secured credit appear to have been overcome in day-to-day operations, even though the methods used may not be legally valid and are known not to be so by the lenders.

The conflict between lenders and the rights of third parties (such as purchasers of secured property), and the enforcement of securities in law and practice, are dealt with in chapters III and IV. The last chapter draws conclusions with respect to the present validity of the basic principles of existing law. Coates states that the real area of conflict is not so much in the relation between lenders and borrowers (as the law seems to presuppose now). On the whole his study suggests that a feeling of mutual confidence exists between the lender and the debtor (p. 76). The real area of conflict, he believes, is between the lender and third parties, i.e. the preservation of the lenders security against third parties. The author raises the question briefly whether the present situation has not served to seriously discourage the use of chattel secured credit to farmers (p. 77). The favorable effect of the Uniform Commercial Code on credit transactions, should it be enacted, is clearly shown throughout.

Coates' book is timely because chattel-secured farm credit is probably becoming more important than real-estate secured credit. The more commercialized farm operations become, the more important becomes the role of chattel-secured loans. Hence the more urgent is the need for clarifying legal issues connected with such loans. It is strange that state legislatures, which supposedly represent interests of lenders more than those of borrowers, have not been subjected to much stronger pressure to bring legislation up-to-date and to give lenders the *legal* security which they do not now have in so many cases. The fact of the matter is that this is a highly delicate subject for public discussion. The matter of

enforcement of secured loans has always created much heated controversy. In the background is often the recollection that when economic conditions are depressed and when the adequacy of existing laws are put to the most severe test, the machinery for the enforcement of loans is seriously endangered. Then, in an economy in which credit plays a crucial role, a collection policy which uses the existing laws and is ruthlessly pursued could wreck the basic institutions of our society.

Lenders are not necessarily unhappy with the legal *status quo*. The bargaining power in the loan contract is usually on their side. Coates states that lenders and borrowers who are not legally trained, *place a great deal of emphasis on the written word* (ital. mine). In most situations, whatever the form says is considered the "law" on that subject (p. 17). But when Coates discusses enforcement of security, and specifically the problem of the use of the criminal sanctions, he also states that "it is difficult to get a clear picture of precisely what does happen because it is not a popular subject of conversation among the lenders who use it" (i.e. the threat of using criminal provisions). Thus, in the narrower framework of law enforcement, it is probable that Coates' conclusions as to the "real area of conflict" are correct, for a period of rising prices where lenders and borrowers have a "feeling of mutual confidence" and where fundamentally lending is not a high risk activity. In the interest of a well organized society and the respect for law, haste should be made to enact the proposed Code.

What of the effect of present-day and proposed legislation on the general availability of credit? If the provisions of the Code with respect to chattel secured loans should be enacted, would it really increase credit to farmers? Have the antiquated provisions of Wisconsin and other states prevented lenders from loaning? It is suggested that the proposed changes will affect the *general* farm credit picture only little or not at all, because in this area of credit the matters pertaining to security appear to be mostly fringe problems. It is interesting that just recently similar questions have been raised with respect to federal farm bankruptcy and moratorium bills similar to the Frazier-Lemke Act. Large lenders have stated that the passage of such a bill would seriously impair their security and hence restrict credit to farmers. But past history does not substantiate this claim. Therefore laws which deal mainly with the problem of contingencies may have little direct effect on the present credit situation (i.e. availability of credit). Lenders will probably continue to pay more attention to general business conditions and the character of the borrowers than to the provisions of the laws which apply in contingencies.

Ernest Feder

University of Nebraska

NEWS NOTES

Harold Abel, of the Denver Office of the Market Organization and Costs Branch, Agricultural Marketing Service, received the Department of Agriculture's Superior Service Award in May. The award was made for demonstrating exceptional skill in working with representatives from the ten Western States to plan and carry through research projects in the economics of marketing Western livestock.

Kendall Adams was appointed to the retailer education extension project at Michigan State College in September 1954. His graduate work was in Business Administration at Michigan State College.

Raymond L. Anderson has joined the staff of the Production Economics Research Branch, Agricultural Research Service, United States Department of Agriculture, stationed at Montana.

Barkat A. Azhar, formerly a graduate student at the University of Illinois, has accepted a position with the Planning Board, government of Pakistan.

William L. Barr has returned to his duties as Professor of Farm Management at the Pennsylvania State University after a 4-month leave to work with the Interstate Milk Producers Association on producer relations.

E. L. Baum, formerly of Washington State College, has joined the staff of the Tennessee Valley Authority, where he will carry on a program of research related to the economics of fertilizer use.

Manning H. Becker, Assistant Professor of Agricultural Economics at Oregon State College, resigned on October 1 to take a similar position in the Extension Service at Oregon State College. Professor Becker will do extension work in the field of farm management and will also coordinate the Farm and Home Planning Program which is being expanded at Oregon State College.

Merrill K. Bennett, Director of the Food Research Institute, became a member of the Food and Nutrition Board of the National Academy of Sciences on July 1, 1954.

William E. Black, formerly with the Wisconsin Agricultural Extension Service, has joined the staff of the Florida Agricultural Extension Service as Marketing Specialist.

Paul Titus Blair joined the staff of Mississippi State College, July 15, 1954. He was formerly employed as Assistant Manager of the Madison County Cooperative at Canton, Mississippi.

J. F Booth, Chief of the Economics Division, Canada Department of Agriculture, recently returned from an assignment in Malaya with the International Bank for Reconstruction and Development.

Karl Brandt, Associate Director of the Food Research Institute, is serving as an exchange professor from Stanford University in the Department of Economics at the Free University of Berlin during the winter semester 1954-55.

C. Arthur Bratton, Extension Professor of Farm Management at Cornell has been appointed Project Leader in Extension. He replaced Dr. M. C. Bond who was made Director of the Cornell Extension Service on July 1, 1954.

George K. Brinegar of the University of Connecticut is on Sabbatic leave with the National Bureau of Economic Research where he is studying agricultural credit.

Ernest Evan Brown, formerly Field Asistant at the Florida Experiment Station, Gainesville, has joined the Clemson College Agricultural Economics staff.

W. D. Buddemeier, University of Illinois, has been promoted to the rank of Associate Professor.

Kendall S. Carpenter was recently appointed Assistant Professor of Cooperative Marketing at Cornell. Formerly he was marketing specialist, Organization and Costs Branch, Market Research Division, Agricultural Marketing Service, U. S. Department of Agriculture, located at Cornell.

Thomas F. Carroll was Technical Secretary of the United Nations Food and Agriculture Organization's Center on Land Problems for Asia and the Far East, held in Bangkok, Thailand, between 22 November and 11 December 1954. This Center was the second regional gathering of land reform experts sponsored by FAO. A number of prominent agricultural economists from the United States and from Asian countries participated. Among these were Rainer Schickele, newly appointed head of the Land and Water Use Branch in FAO, Kenneth H. Parsons of the University of Wisconsin, M. L. Dantwala of the University of Bombay, S. M. Akhtar, Punjab University, Keiki Owada, Ministry of Agriculture in Tokyo and Pablo N. Mabbun, Univerity of the East in Manila. A similar Center on land problems for the Near East region is planned by FAO for late this year in Baghdad, Iraq.

James P. Cavin returned to the Department of Agriculture on October 18 to become Chief of the Statistical and Historical Research Branch in the Division of Agricultural Economics of the Agricultural Marketing Service. He was with the Office of Statistical Standards of the Bureau of the Budget and replaced Karl A. Fox who became associated with the Council of Economic Advisers on August 1.

Walter Chryst is in charge of the Land Tenure work in the Production Economics Research Branch, ARS. He succeeded Marshall Harris, who is on a new assignment in Iowa.

Robert Coffman has transferred from the Production Economics Research Branch, ARS, to the Bureau of Land Management, Department of Interior. He reported for duty at the Land Office in Anchorage, Alaska, in November, to work on studies of homesteading, and use and management of public lands in Alaska.

Maynard C. Conner, Associate Professor of Marketing, Virgina Polytechnic Institute returned to his duties of teaching and research July 1, 1954 after a term of graduate work at Cornell University.

Thomas Creager joined the staff at Michigan State College in a retailer education extension program during September 1954. Mr. Creager did his graduate work in Business Administration at Michigan State.

C. Richard Creek, Associate Professor of Agricultural Economics at Colorado A & M College, accepted a two-year assignment, effective September 26, 1954, at the University of Peshawar in the Northwest Frontier Province of Pakistan. He is a member of a team of consultants from Colorado A & M College whose principal mission is to assist the University of Peshawar through the F. O. A. in establishing a university system patterned after the Land-Grant colleges in the U. S.

L. C. Cunningham, Extension Professor of Farm Management, Cornell University, received the Superior Service Award from the United States Department of Agriculture for his vision, ingenuity, and preseverance in developing an outstanding educational program dealing with the Economics of Dairy Farming.

Robert Lee Davis, Jr. returned to Mississippi State College, after a leave of a heart attack on November 12. He had served the Department for more than 18 years.

Chester C. Davis will join the Department of Agricultural Economics at the University of California as a Regents Professor for the Spring Semester of 1955. He will assist in teaching and will advise on long-range research program.

Robert D. Davidson, Production Economics Research Branch, ARS, died of absence to do graduate work at the University of Kentucky.

Howard G. Diesslin has accepted the position as Associate Managing Director, Farm Foundation, February 1, 1955. Dr. Diesslin was in charge of the research and teaching work in agricultural finance in the Department of Agricultural Economics at Purdue University.

Daniel C. Dvoracek, Associate Professor and Extension Economist, University of Minnesota, passed away October 21, 1954. Mr. Dvoracek was well known throughout the state for his work in agricultural marketing and with cooperatives. He was a pioneer in developing cooperative councils in both the state and nation. Recently he has been active in developing group discussion projects in rural areas and has gained national recognition for his work.

John L. Fischer accepted appointment at Michigan State College in Marketing Extension, effective December 1954. He previously was on the staff at the University of Tennessee.

W. J. Foreman, who received his Ph.D. degree from the University of Illinois in 1952, was released from the Air Force and has accepted a position with the Georgia Agricultural Experiment Station at Griffin.

G. W. Forster, who retired as Head of Department of Agricultural Economics at North Carolina State College in 1951, is now Emeretus Professor of Agricultural Economics. He is slowly recovering from his illness of the past three years.

Roy M. Gilcreast, Production Economics Research Branch, ARS, stationed at Fargo, N. Dak., died on October 19 after a short illness. He had served the Government in various capacities for more than 20 years.

J. Clayton Gilson has been appointed Assistant Professor in the Department of Agricultural Economics and Farm Management at the University of Manitoba.

Conrad Gislason is engaged on a special study of Grain Storage Policy in the Department of Agricultural Economics at the University of Connecticut.

Robert L. Gustafson has been appointed Assistant Professor of Economics at the University of Chicago beginning with the fall quarter, 1954. He will have major responsibility for the research to be conducted under an RMA contract with the University to determine the costs of alternative price stabilization programs.

A. Bartlett Hague, Jr. was appointed social scientist in the Farm Population and Rural Life Branch of the Division of Agricultural Economics, AMS, USDA on November 1. He was associated with the Department of Conservation, School of Natural Resources, University of Michigan at Ann Arbor as a research assistant, working toward his doctorate in Sociology.

D. O. Hammerberg, State Milk Administrator for Connecticut and formerly head of the Department of Agricultural Economics at the University of Connecticut, was elected President of the International Association of Milk Control Agencies.

Marshall Harris, Production Economics Research Branch, ARS, is to be stationed at the Agriculture Law Center, State University of Iowa, Iowa City. He will supervise cooperative research on the interrelations of legal institutions and the attainment of economic objectives in agriculture. This newly established research program is a cooperative undertaking of the Law School, the Iowa Agricultural Experiment Station and the Production Economics Research Branch, ARS.

Clive R. Harston was promoted to Associate Professor of Agricultural Economics at Montana State College on October 1, 1954.

G. V. Haythorne, President of the Canadian Agricultural Economics Society, was recently appointed assistant deputy-minister, Canada Department of Labour.

Burnell Held, formerly of Michigan State College, has been appointed Associate Professor of Agricultural Economics Extension at the Pennsylvania State University. Dr. Held, who earned his Ph.D. at Iowa State College, will be working largely on farm policy.

Henry A. Homme, formerly at Iowa State College, has joined the staff at North Caroline State College to do research in milk marketing.

R. Brian How joined the staff of the Ontario Agricultural College in September as Associate Professor supervising research in marketing. Dr. How comes from University of Saskatchewan.

Henry Hudek joined the staff of Colorado A & M College in September as Assistant Professor of Agricultural Economics and Assistant Agricultural Economist in the Agricultural Experiment Station. He recently received his Ph.D. degree from Iowa State College. His research work will be in the field of marketing poultry and dairy products.

George W. Irving, Jr. has been appointed Deputy Agricultural Research Service Administrator in charge of research. He comes to the new assignment from the Biological Sciences Branch of the Agricultural Marketing Service, of which he was Chief. Prior to that, he was Assistant Chief of the former Bureau of Agricultural and Industrial Chemistry.

A. William Jasper, who finished his work for the doctorate at Cornell University in September 1954, is Managing Editor of the *Poultry Tribune,* Watt Publishing Co., Mt. Morris, Illinois.

Lewis P. Jenkins resigned from Mississippi State College July 30, 1954 to accept a position as Manager of the Leflore Dairy, Greenwood, Mississippi.

William F. Johnstone has been promoted to Associate Professor of Agricultural Economics Extension at the Pennsylvania State University.

George G. Judge, Assistant Professor of Agricultural Economics at the University of Connecticut, has accepted a position as Associate Professor at Oklahoma A & M College.

Charles E. Kellogg, Assistant Administer for Soil Survey, Soil Conservation Service, visited the Gold Coast in August 1954 at the request of the government of that country to consult with Gold Coast officials about plans for agricultural research and land development. Particular interest centered on the possibilities of irrigation from a new dam proposed as a part of the Volta River Scheme which will produce power for the manufacture of aluminum. Following the visit to the Gold Coast, Kellogg attended the Fifth International Congress of Soil Science in Leopoldville, Belgian Congo, where he acted as Vice-President of the Congress and gave a general lecture on soil conservation. Afterward he

advised with the Belgians on land development problems in the Haut Katanga in the southeastern part of the Congo. On the return journey he spent some time with the National Agricultural Advisory Service in Britain.

Gerald E. Korzan, Associate Professor of Agricultural Economics at Oregon State College, is taking a leave of absence from his position to represent Oregon State College on a mission to Kasetsart University at Bangkok, Thailand. Dr. Korzan will be a member of a six man team from Oregon State College which will spend up to two years in Thailand on a mutual assistance program with Kasetsart University.

Marvin Kottke, who has been working toward a Ph.D. at the University of Minnesota, was recently appointed assistant professor of Agricultural Economics and Farm Management at the University of Connecticut.

R. L. Kristjanson, who has been working toward a Ph.D. at the University of Wisconsin, has accepted a position as Assistant Professor of Agricultural Economics at South Dakota State College, effective February 1, 1955.

George M. Kuznets, Professor of Agricultural Economics at the University of California, is spending the remaining five months of an eight-month leave of absence at the National Bureau of Economic Research in New York City making a study of Soviet Agriculture with particular emphasis on measurement of rates of growth.

Kermit Larson resigned from the staff of the Market Organization and Costs Branch, Agricultural Marketing Service, USDA, last September to accept a position with Oscar Mayer and Company in Madison, Wisconsin.

Clayton Libeau, formerly at the University of Nebraska, has joined the staff at North Carolina State College to do extension work in poultry marketing.

William F. Lomasney resigned from the Economics Branch of the Federal Extension Service to accept a position with the University of Illinois Agricultural Extension Service to do distributor and consumer education work in the city of Chicago.

E. A. Lutz, Professor of Public Administration, returned to his duties in the Department of Agricultural Economics at Cornell after spending his sabbatic leave doing research in Albany and Washington on Inter-governmental Relations in the field of public welfare.

Voyce J. Mack, who received his doctorate at Cornell in 1953, is Associate Professor of Agricultural Economics, School of Agriculture, Virgina State College, Petersburg, Virgina. (Not previously reported to *This Journal.*)

Frank Maier joined the staff of the Production Economics Research Branch, ARS, on October 20, coming from Vanderbilt University where he had been engaged in research for the last 2 years. His work with the Production Economics Research Branch will be on Land Tenure and he will serve as Regional Project leader for the Southeast Land Tenure Research Committee.

Sheridan T. Maitland was appointed Labor Economist in the Farm Population and Rural Life Branch, Division of Agricultural Economics, AMS, USDA, on September 13, transferring from the Department of Labor.

William J. Martin has joined the Federal Extension Service to serve as Cotton Utilization Specialist. He is assigned to the Division of Agricultural Economics Programs and will have headquarters at Clemson College, South Carolina. Mr. Martin is a graduate in textile engineering of the Georgia School of Technology and has had graduate work at Georgia Tech. His employment experience includes work with texile manufacturing plants, research on market outlets for

cotton in the U. S. Department of Agriculture, and two foreign missions sponsored by the National Cotton Council and the Department of Agriculture. The Extension educational program on cotton utilization will deal mainly with problems of the textile industry in the South, New England, and other appropriate sections of the country.

Robert S. McGlothlin was appointed Instructor in Agricultural Economics at Montana State College on September 1, 1954.

Raymond D. McKinney has been appointed assistant professor of Agricultural Economics in the Extension Service at Kansas State College. He will assist with farm management and the farm planning program in Kansas. Mr. McKinney was on leave from the Farm Home Administration in Nebraska during the 1953-54 academic year for graduate study at Harvard University.

John Mellor has been appointed Assistant Professor in the Department of Agricultural Economics at Cornell. He is teaching Agricultural Geography. This past summer he spent three months traveling throughout the United States studying types of farming regions. Prior to completing the requirement for the Ph.D. in September 1954, Mellor held the position of lecturer in Agricultural Geography at Cornell.

Charles C. Micheel, formerly with the Bureau of Reclamation, Department of Interior, stationed at Huron, South Dakota, is with the Production Economics Research Branch, ARS, stationed at Kansas State College, Manhattan, Kansas. His work will be on the economics of conservation.

Woodson W. Moffet, Regional Dairy Marketing Project Leader in the Southern region, resigned June 30, 1954, to become Supervisor, Milk Audit Law, State Department of Agriculture at Jackson, Mississippi.

Clarence A. Moore, formerly of the University of Chicago, has been appointed assistant professor in farm management at the Agricultural and Mechanical College of Texas.

Wilford H. M. Morris, formerly at Iowa State College, joined the Agricultural Economics Department at Purdue University December 1, 1954. Dr. Morris will spend most of his time on the recently developed new project to determine energy requirements and methods of improving work procedures of agriculture. This project will give special emphasis to the farm worker with cardio-vascular disease.

Thomas Morrison, in Poultry Marketing Extension work at the University of Connecticut, has been promoted to Assistant Professor.

Herman L. Myers, formerly with the Bureau of Agricultural Economics and more recently with the Foreign Operations Administration in Washington, transferred to the United States Operations Mission in Norway to assume the post of Economist and Program Officer.

C. W. Nauheim, Production Economics Research Branch, ARS, is stationed at Manhattan, Kansas, where he is the Branch representative on cooperative research with Kansas State College.

Glen T. Nelson, Assistant Professor of Agricultural Economics at Oregon State College, resigned his position on November 30 to accept a position in agricultural economics at Brigham Young University, Provo, Utah. Dr. Nelson assumed his duties as Associate Professor of Agricultural Economics on January 1. While at Oregon State College, Dr. Nelson did extensive research and teaching in the field of milk marketing. He will teach marketing classes at Brigham Young University.

Peter Nelson, formerly Head of Agricultural Economics at Oklahoma A & M College, has joined the staff at State College of Washington as Visiting Professor of Agricultural Economics.

Ottar Nervik, Associate Professor at South Dakota State College, has been granted a leave of absence to undertake a two-year assignment in Iran. He left September 1 for his new position which will be concerned with community development under the Near East Foundation in Iran.

Frank Orazem has joined the staff of the Production Economics Research Branch, ARS. He is stationed at Ames, Iowa, where he will cooperate with the Iowa Agricultural Experiment Station in an analysis of farming adjustment opportunities in the butterfat areas.

Ki Hyuk Pak, graduate student in agricultural economics, University of Illinois, is spending the current year in field studies of Korean agricultural problems through cooperation with the American-Korean Foundation of New York City.

Mayland Parker completed the requirements for the doctorate in October 1954 and has been appointed Assistant Professor of Land Economics at Cornell University. He will devote full time to land classification work.

George L. Peterson was Food and Agriculture Officer in the ECA/MSA/FOA Mission to Denmark from the beginning of the Marshall Plan to 1954 and has since January 1954 occupied that post in the Mission to Yugoslavia.

Weber H. Peterson accepted a position with the Foreign Agricultural Service of the U.S.D.A. in November 1954. Dr. Peterson formerly was with the U. S. Chamber of Commerce doing agricultural work.

Homer Preston of the Market Organization and Costs Branch, Agricultural Marketing Service, USDA, made a study of dairying and dairy marketing in Peru during October. The study was made for the International Development Services, Inc., of New York City.

Thomas S. Rackham was appointed Instructor in Agricultural Economics at Montana State College on July 1, 1954.

M. P. Rasmusson and Benjamin A. Domonick of Cornell are continuing to serve respectively as director and associate director of research for the New York Temporary Commission on Agriculture. They have been conducting a special study to determine what can be done to rehabilitate the Washington Street Produce market in New York City and/or what can be done to improve other facilities for the distribution of food in the New York Metropolitan area.

Lawrence Reuss, Production Economics Research Branch, ARS, and his wife were critically injured in an automobile accident near Memphis, Tennessee, as they were returning to Florida from a vacation in Illinois.

Fred R. Robertson, Jr. has returned to the TVA Staff following a year's graduate work at the Littauer Center, Harvard University.

Wayne Robinson, who has been working toward his Ph.D. at the University of Wisconsin, has accepted a position as Assistant Professor of Agricultural Economics at Kansas State College.

Walter B. Rogers was appointed Instructor in Agricultural Economics at New Mexico A & M, effective October 1. He recently completed his Master's Degree at the University of Arizona.

Vernon Ross, who was engaged in county agent work in Tennessee, has been appointed Assistant Professor in the Department of Agricultural Economics at

the University of Connecticut. Mr. Ross received an M.S. degree at the University of Connecticut in 1950.

Vernon W. Ruttan, formerly on the Government Relations and Economics Staff at T.V.A., Knoxville, joined the Department of Agricultural Economics at Purdue University December 15, 1954. Dr. Ruttan will do research and teaching in the marketing area.

Fred B. Saunders returned from Iowa State College in September to become Assistant Economist in the Department of Agricultural Economics at the University of Georgia. He has finished all of his requirements for the Ph.D. except the thesis. His current research work involves marketing problems of part-time farming.

Zach Savage has been promoted to Agricultural Economist on the staff of the Florida Agricultural Experiment Station.

T. W. Schultz, D. Gale Johnson and George Tolley of the University of Chicago have received a three year grant from Resources for the Future, Incorporated, to study public pricing of resources relative to grazing and irrigation in the west.

Frank Scott, Jr., formerly at the University of Nevada, has accepted a position in marketing with the University of Hawaii.

Robert S. Smith was recently appointed Associate Professor of Farm Management at Cornell. Formerly he was Coordinator of the young adult extension program at Cornell.

Mrs. Marjorie Smythe served as an Assistant Professor at South Dakota State College during the fall and winter terms.

L. Orlo Sorenson, formerly of the University of Minnesota, has been appointed Assistant Professor of Agricultural Economics, Kansas State College.

C. C. Spence was granted leave-of-absence from the Economics Division, Canada Department of Agriculture, for a period of one year. He has gone to Iran under the Technical Assistance of F. A. O. to deal with irrigation problems.

Milton Spencer has been appointed Professor of Economics at De Paul University in Chicago. He also is serving as consultant to the Market Research Department of Armour and Company, where he formerly worked full time after completing his doctorate at Cornell in February 1954.

Bernard F. Stanton is Assistant Professor of Farm Management at Cornell. He completed his doctorate at Minnesota. Professor Stanton joined the Cornell staff in the fall of 1953.

J. M. Stepp, Professor of Agricultural Economics at Clemson College, is Second-Vice-President of the Southern Economic Association for the year 1954-55.

Delwin M. Steven, formerly a member of the Departments of Agricultural Economics at Wyoming and Colorado A & M, and currently enrolled in graduate work at Cornell, was in an automobile accident in July 1954. He is recovering slowly from a badly broken leg in the Veterans Hospital at Syracuse, New York.

H. L. Stewart, Production Economics Research Branch, ARS, has been designated a member of the Department's Advisory Board of Appeals, which considers appeals from Forest Service decisions on grazing permits and related matters. The Board is advisory to the Secretary of Agriculture.

James H. Street was granted a leave of absence from Rutgers University for the acedemic year beginning in March, 1955, to serve as Visiting Professor of Economics at the National University of Paraguay, Asuncion, under a Smith-Mundt grant.

Lester G. Telser has been appointed a cooperative agent by the U. S. Department of Agriculture and the Department of Economics at the University of Chicago to study certain effects of the farm price support program on hedging and interseasonal price movements.

John E. Thompson, recently joined the staff at South Dakota State College. He is engaged in a study of Rural Public Finance and Rural Taxation.

T. S. Thorfinnson, Production Economics Research Branch, ARS, stationed in Nebraska, is making plans for a new cooperative study with the Nebraska Agricultural Experiment Station. The study is to appraise alternative systems of farming on sandy soils of the North Platte River irrigated area.

Edwin C. Voorhies, Professor of Agricultural Economics, University of California, will spend a six-months' sabbatical (February 1, 1955-July 31, 1955) in Spain, Portugal, Western Europe and the Scandinavian countries studying the agriculture of those countries.

Martin Waananen was appointed Assistant Agricultural Economist at the State College of Washington on September 1, 1954.

Willard Wall, formerly of the Farm Income Branch, Division of Agricultural Economics, AMS, USDA, transferred to the Department of Defense–Navy on October 24.

Clinton F. Wells retired as Analytical Statistician in the Farm Income Branch of the Agricultural Economics Division, AMS, USDA, on November 30 after having completed more than 25 years of service. Mrs. Doris Rafler replaces Mr. Wells and will work in the field of foreign demand. She transferred from Foreign Agricultural Service.

Howard S. Whitney has resigned at Oklahoma A & M College to accept a similar position in Agricultural Economics at Texas A & M College.

G. P. Wibberly, who received his master's degree from the University of Illinois in 1939, has been appointed as the first Professor of Land Economics at Wye College, England.

Roy H. Wilcox, University of Illinois, has been promoted to the rank of Professor.

John E. Wills, University of Illinois, has been promoted to the rank of Professor.

Walter J. Wills, formerly with the American Trucking Association, accepted a position as Extension Marketing Specialist at State College of Washington on September 1, 1954.

Garland P. Wood, who has been working toward his Ph.D. at the University of Wisconsin, has accepted a research position at the University of Nevada.

Philip A. Wright has been appointed Associate Professor at Ontario Agricultural College.

The following agricultural economists have joined the Washington staff of the Market Organization and Costs Branch, AMS, USDA: Rollin O. Dunsdon, who was awarded the Ph.D. degree at the University of Wisconsin in January 1954; Leo R. Gray, formerly with Extension Service at the University of Massachusetts; Milton Heins, who came from the Wyoming Cooperative Wool Marketing Association; Charles W. Peters, formerly a member of the Agricultural Economics Department at the University of Hawaii; and Fred Stein, who was employed by a frozen food distributing company.